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NOTICES:—All communications relating to editorial matter should be addressed to the Editor, who will be pleased to consider articles or contributions dealing with modern chemical developments or suggestions bearing upon the advancement of the chemical industry in this country. Communications relating to advertisements or general matters should be addressed to the Manager.

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Good-bye to 1927

THE year that closes to-day marks the end of a period of exceptional anxiety to all engaged in chemical industry. The year that begins to-morrow promises better things, and if industrial co-operation and peace continue, may witness a definite forward movement throughout British industry. The effects of the coal strike, which were felt acutely in the heavy chemical, dyestuffs, and gas industries, and which persisted longer than most people had expected, are coming to an end, though the losses have not yet been made good, and will not be for a long time to come. The monthly returns of trade have for some time past shown signs of improvement, and the returns for November left no doubt as to the setting in of an all-round improvement. The result to-day is a better spirit throughout British chemical industry. There is a general belief that the lowest point has been passed and that the curve is moving upward. This confidence is itself a considerable asset. Without it, trade policy can be

little more than negative precaution against undue risks; with it, trade becomes once more positive in its enterprise and outlook, and when every trader acts in this spirit an increased volume of business is assured. Sir William Alexander, M.P., concludes his critical and balanced review of the chemical trade of the past year with the conservative prediction that "the prospects for 1928, given a continuance of industrial peace, are such as to warrant a feeling of optimism." Nothing, it is to be hoped, will be allowed to obstruct the fulfilment of this hope.

The Nitrogen Industry

The articles we publish to-day on this branch of chemical industry from Colonel G. P. Pollitt, Dr. E. B. Maxted, and Mr. A. B. Bruce, sufficiently indicate the enormous growth of the nitrogen industry in this country within the lifetime of THE CHEMICAL AGE. It seems only a few steps back when we were dealing with that monumental work, now out of print, the report of the Nitrogen Products Committee, in which the prospects of starting a synthetic nitrogen industry were exhaustively explored. A little later Billingham-on-Tees—at the time little more than a site with a few buildings and roads—was sold to Brunner, Mond and Co. A glance at Dr. Pollitt's article will show the almost miraculous progress that has since been made. On Christmas Day of 1924 the first ammonia was made at Billingham—in itself a remarkable achievement. Each year since has marked a notable increase of production, and the rate of output is now equivalent to about 70 tons of sulphate a day. A further unit, nearly completed during the past year, will shortly start production. Its capacity will be 165 tons of ammonia per day, combined as sulphate and other products. This unit includes also a plant for the production of methanol from water gas by a high-pressure catalytic process, very similar to that involved in the synthesis of ammonia. These expansions are to be continued, as regards both the size of the plant and the variety of the products.

A gigantic commercial and technical success of this order brings its own problems in its train. The most practical is the finding of outlets for the enormous and ever-increasing production. In view of the increase of synthetic nitrogen plants throughout the world the British Sulphate of Ammonia Federation recently uttered a serious warning as to the inevitable effect on prices if consumption fails to keep pace with production. While even the present output seems enormous, as compared with the standards of a few years ago, the possibilities on the other hand are regarded as almost without limit; research and propaganda are the methods relied on to open up new fields of usefulness, especially for nitrogenous fertilisers. This aspect of the matter is ably dealt with by Mr. A. B. Bruce, editor of publications to the

Nitram Agricultural Research and Advisory Department.

For the eighth year in succession Dr. E. B. Maxted contributes his scholarly review of nitrogen developments throughout the world during the past year, as shown in the principal contributions and patents. The manner, he remarks, in which the synthesis of ammonia, in spite of unparalleled technical difficulties, has justified the expectations of ten years ago may well warrant the existing feeling of confidence in still further extensions, notwithstanding the present anomalous ratio between production and consumption. At the same time it is interesting to have the opinion of so careful a student that, given the proper technical and fiscal conditions, natural nitrates should continue to hold their own with the synthetic product for many years to come.

The Dyestuffs Industry

The position of the dyestuffs industry during 1927 is reviewed comprehensively by Mr. Sutcliffe Smith (Chairman of the Colour Users' Association) from the commercial point of view and especially in reference to the interests of dyestuffs consumers, and by Mr. L. J. Hooley, of the research staff of Scottish Dyes, Ltd., on the technical and production sides. Mr. Smith deals frankly with the question of prices, and pleads again that British users shall be able to obtain their dyewares at prices that will enable them to compete with other users in the world's markets. He regards price reduction as dependent on production and export, and he draws attention pointedly to the cost of raw materials, such as intermediates, which the British dyestuff maker has to pay as compared with the Continental maker. The fusion of British dyemaking and chemical interests Mr. Smith regards as a great step forward; in addition, he suggests, especially for the attention of the Dyestuffs Development Committee, the publication of official information similar to that contained in the United States Census of Dyes, and he cordially supports the movement for bringing dyestuffs and intermediates production into touch with the research work carried out in University laboratories.

Mr. Hooley, who is already familiar to our readers through his informing articles in our Monthly Dyestuffs Supplement, gives a glimpse of the maker's point of view on the price problem, and conveys a hint that price concessions, if obtained at the expense of future development, may not be the undiluted benefit they might at first appear. The volume of technical work during the year he describes as greater than ever, even if no discoveries of outstanding importance have been made, while the prestige of the chemical industry to-day stands high, and the year has again witnessed the production of some very important dyes and dyestuffs by British manufacturers.

The Fine Chemical Industry

Steady progress is the note of the careful review of the British fine chemical industry in 1927, contributed by Mr. C. A. Hill, the chairman of British Drug Houses. Development and progress in several branches of manufacture are reported, particularly in the pharmaceutical group, while notable achievements have to be recorded in the production of hormones and vitamins. As a consistent supporter of the Safeguarding of Industries Act, Mr. Hill notes with regret

that the stimulus afforded to British fine chemical manufacturers, by the renewal of the Act for another ten years, has received a set-back to some extent by the removal from the list of dutiable articles of a considerable number of chemicals. Taking a cautious view of the future, Mr. Hill looks for better times in the new year.

Chemical Inventions of the Year

An article of exceptional interest to research, technical, and library staffs is the review of the chemical inventions of the year by our Patents Correspondent. This contribution, admirably compressing within reasonable limits an immense volume of information, indicates the remarkable range and activity of chemical invention throughout the world, which is usually accepted as a test of the vitality of an industry. Judged by this standard, the chemical industry may be regarded as one of the most progressive of all, and in every branch of it improvement has been evident.

It will surprise many readers to learn that about three-fourths of British chemical patents are held abroad, mostly in Germany, Switzerland, and France, while taking the field of invention over all industries, about 20 per cent. of British patents come from Germany, 6 to 8 per cent. from France, 2 to 4 per cent. from Switzerland, 20 per cent. from the United States, and 4 to 6 per cent. from the British Empire. What our Patents Correspondent regards as possibly the most remarkable development has been in the number of applications for patents by the I.G. Farbenindustrie, which this year is about double that of 1926, and now amounts to an average of about two per day.

Chemical Engineering and Metallurgy

The notes on chemical engineering progress during the year, contributed by Mr. Sydney J. Tungay (a contributor, it may be recalled, to the first issue of THE CHEMICAL AGE), indicate the many directions in which chemical engineering is keeping pace with the demands in the design and construction of plant. This is one of the fields, like synthetic nitrogen and dyestuffs, in which a new industry or profession has been brought into vigorous existence within a single decade. It seems only yesterday when the term "chemical engineering" was treated rather as a joke, and the enthusiasts who organised the Chemical Engineering Group were regarded as well-meaning but not very practical people. The Group, which will always be remembered as the pioneer body, has every reason to look back with satisfaction on the work it undertook. It has seen an Institution of Chemical Engineers soundly established, with a steadily growing membership and a high reputation, and it has seen, too, chemical engineering pass from a mere phrase into a practice of the highest importance. The recent triumphs of British chemistry, indeed, have largely consisted in the engineering efficiency with which laboratory knowledge has been converted into commercial production.

Closely allied with this subject is that of metallurgy as a science very closely akin to chemical industry. On this Sir Robert Hadfield writes with his usual authority. Of particular interest to chemical firms is the production of metals and alloys with very high degrees of resistance to corrosion, hot acids, etc., and in no quarter is the service that metallurgy has rendered better understood or appreciated than in

chemical works, where the tests to which plant is exposed are of the severest character. It is good to find Sir Robert Hadfield, who has himself achieved some great results in steel research, still insisting on research, especially into molecular properties and structure, as the key to future progress.

Some Notable Events

Perhaps the most notable single event of the year has been the grant to Mr. Novomeysky and Major Tulloch of a concession to exploit the mineral resources of the Dead Sea. There are possibilities in this direction of a very large order, and in the right hands Palestine may possibly become a great centre of chemical industry. The policy inaugurated last year by the formation of Imperial Chemical Industries has been developed in several directions—for example, in the formation of a research staff in association with Nitram, Ltd., the constitution of an advisory research council, the publication of an important labour programme, and the decision this week empowering the directors to increase the preference capital from £16,220,000 to £22,800,000 by the issue of 6,580,000 preference shares of £1 each. The great headquarters building on the Thames near Westminster is progressing towards completion, and in this connection may be noted the retirement of Sir Frank Baines from the post of principal architect to the Office of Works to become consultant on architectural and constructional work to I.C.I.

Among other notable events may be mentioned the inauguration of the International Superphosphate Manufacturers' Association in London; the centenary of the discovery of aluminium by F. Wohler; the appointment of Mr. H. T. Tizard as secretary to the Committee of Council for Scientific and Industrial Research in succession to Sir Frank Heath, retired; the amalgamation of the Institution of Fuel Technology and the Institution of Fuel Economy Engineers; the announcement by the I.G. of a new anaesthetic known as EtO7; the celebration of the golden wedding of Professor and Mrs. Armstrong; the opening of the new laboratories of the British Paint, Colour, and Varnish Research Association at Teddington; the centenary of the birth of M. Berthelot; and the jubilee celebrations of the Institute of Chemistry of Great Britain.

The field which in the immediate future will engage most scientific attention is that of fuel technology. The work of Bergius, Fischer, Patart, and others abroad, together with the research into low-temperature carbonisation in this country, has opened out immense possibilities in the treatment of raw coal. A certain reserve may well be cultivated respecting the commercial triumph of this or that particular system and the salvation of the entire coal industry by the adoption of any one process. What is certain, however, is that the science and technology of fuel are making rapid advances, and that commercial progress, in due course, must inevitably follow.

Books Received

- FORTSCHRITTE IN DER KALI-INDUSTRIE. By Dr. C. Hermann. Leipzig: Theodore Steinkopff. Pp. 118. 8s.
REPORT ON THE COMMERCIAL, ECONOMIC AND FINANCIAL CONDITIONS OF THE ARGENTINE REPUBLIC, September, 1927. By H. O. Chalkley. London: H.M. Stationery Office. Pp. 90. 2s. 6d.

The Calendar

1928 Jan.		
2	Institution of the Rubber Industry (London Section): "Synthetic Resins." A. A. Drummond.	Engineers' Club, Coventry Street, London.
5	Society of Dyers and Colourists (West Riding Section): "Some Causes of Uneven Dyeing." H. R. Hirst.	Midland Hotel, Bradford.
6	Society of Chemical Industry (Manchester Section): "The Action of Caustic Alkali on Partially Methylated Cellulose—The Heat of Reaction and Absorption." F. C. Wood and A. C. Alexander.	Manchester.
9	Institute of Metals (Scottish Section): Open Discussion. 7.30 p.m.	39, Elmbank Crescent, Glasgow.
9	Institute of Chemistry (Manchester Section): "Some Inter-relations of Chemistry and Physiology." Professor H. S. Raper.	Royal Exchange Buildings, St. Ann's Square, Manchester.
10	Institute of Metals (N.E. Coast Section): "Permanent Mould Casting in Aluminium Alloys." 7.30 p.m.	Armstrong College, Newcastle-on-Tyne.
10	Physical Society and Optical Society: Eighteenth Annual Exhibition.	Imperial College of Science and Technology, South Kensington.
11	Ceramic Society: "Dust Inhalation with special reference to Silicosis." Professor E. L. Collie.	North Staffordshire Technical College, Stoke-on-Trent.
12	Institute of Metals (London Section): "Segregation in Metals and Alloys." Dr. S. W. Smith. 7.30 p.m.	83, Pall Mall, London, S.W.1.
12	Oil and Colour Chemists' Association: "Some Points in the Manufacture of Zinc Oxide." R. G. Daniels.	8, St. Martin's Place, Trafalgar Square, London.
12	Society of Dyers and Colourists (Midlands Section): "Action of Acids on Wool." S. R. Trotman and Dr. E. R. Trotman. 7.30 p.m.	University College, Nottingham.
16	University of Birmingham Chemical Society: Presidential Address by Professor W. N. Haworth.	University, Birmingham.
17	Society of Chemical Industry (Glasgow Section): "The Fuel Problem." Dr. C. H. Lander. 7 p.m.	39, Elmbank Crescent, Glasgow.
18	Society of Glass Technology: 2.30 p.m.	Manchester.
18	Institute of Metals (Swansea Section): "Some Interesting Properties of Alloys of Nickel." W. T. Griffiths. 7 p.m.	Thomas Café, High Street, Swansea.
19	Optical Society: Ordinary Meeting. 7.30 p.m.	Imperial College of Science and Technology, South Kensington, London.
19	Chemical Society: 8 p.m.	Burlington House, Piccadilly, London.
19	Institute of Chemistry and Society of Chemical Industry (Edinburgh Sections): Discussion on "The Separation of Solids and Fluids." 7.30 p.m.	North British Station Hotel, Edinburgh.
19	Institute of Metals (Birmingham Section): "Heat Resisting Alloys." T. H. Turner. 7 p.m.	Engineers' Club, Waterloo Street, Birmingham.
20	Society of Dyers and Colourists (Scottish Section): Dr. H. Levinstein.	Glasgow.
20	Society of Chemical Industry (Liverpool Section): "The Production and Refining of Cane Sugar." Geoffrey Fairrie. 6 p.m.	University, Liverpool.
20	West Cumberland Society of Chemists and Engineers: "The Lubrication of the Automobile." O. T. Jones. 7 p.m.	Workington.
20	Society of Dyers and Colourists (West Riding Section): Annual Dance.	Queen's Hall, Bradford.
20	Society of Dyers and Colourists (Manchester Section), Joint Meeting with the Manchester Section of the Oil and Colour Chemists' Association: "Azoic and Other Insoluble Colours." Dr. A. E. Everest and J. A. Wallwork.	Milton Hall, Deansgate, Manchester.

British Chemical Industry in 1927

By Brig.-General Sir William Alexander, K.B.E., C.B., C.M.G., D.S.O., M.P.

After reviewing the chief features of the year, the conclusion of Sir William Alexander, whose intimate knowledge of chemicals, artificial silk, dyestuffs, and other industries both here and overseas gives him exceptional opportunities of judging, is that the prospects for 1928, given a continuance of industrial peace, warrant a feeling of optimism.

THE swift recurrence of the Editor's yearly request for a brief review of British chemical industry brings both surprise and satisfaction. Surprise, perhaps a little disturbing, because one had not realised that one could be a year older in apparently so short a span; satisfaction in that the year was unmarked by those anxieties which lengthen out time.

There are no strident passages in the history of growth, however vigorous, when such growth is along normal healthy lines. Development of this nature has characterised the past year. The disturbances of 1926 left a crippling legacy of wasted time and interrupted effort which it has been the endeavour of 1927 to overcome. Looking back on the year, on its manifold activities, on the earnest leadership and the strenuous effort based on vision of possibilities, there can be little doubt that the endeavour has met with very considerable success.

Combination of Interests

The most important movement of the year, in industry generally and not least in the chemical industry, has been towards combination of interests so as to secure the manifest advantages of co-operation, such as the pooling of resources, the cutting out of non-productive expenditure arising out of competition and overlapping, and the unification of aim and leadership in fundamental matters such as research and labour.

"Imperial Chemical Industries, Ltd.," is the outstanding concrete instance of this tendency towards amalgamation. As is well known, it unites the interests of many companies, the great majority of which are directly or indirectly connected with the manufacture of chemicals. The four main companies are Brunner Mond and Co., Ltd., the British Dyestuffs Corporation, Ltd., Nobel Industries, Ltd., and the United Alkali Co., Ltd. In its magnitude as regards capital, capacity and range of production, and ability, whether in research, technique or salesmanship, it is a combination equal to any in the world. In so far as it leads to a revival and expansion of chemical industry, in its national and imperial aspects, it is entirely to be welcomed and good wishes expressed for its prosperity. There are rumours and counter-rumours as to international agreements, but comment is not called for in the absence of any authoritative news. It is felt, however, that the conception of meeting the chemical needs of the Empire by British chemical enterprise is so big that it is worth maintaining unimpaired. The recent speeches of Sir Alfred Mond indicate no desire to modify this view.

One may hazard a guess at some of the difficulties facing the new organisation. There is the complex problem of reconciling the policies of four industrial firms which were self-reliant and self-sufficient in their own spheres. Policies, individual and divergent, adapted to particular needs and aims, have to be fused into one policy; in other words, a greatest common measure has to be found so that all may benefit and none suffer, and the now common business be done even better than were the individual businesses. Much foresight will also be required in future policy so as not to disturb the existing equilibrium between the newly-united interests and chemical and other interests lying outside their sphere. Rumours of inroads into new fields have already raised at home and abroad, especially in America, strong criticism and resistance on the part of those likely

to be affected, and it will take discriminating judgment to decide whether the goodwill of a century is a more valuable asset to build upon or a more costly factor to destroy.

Labour disturbances in this country are rarer in chemical industry than in almost any other. The relations are built on goodwill and understanding and on a generous recognition of hazardous or irksome work. The past year has witnessed a continuance and a development of this sane policy, and in some important cases there has been an official recognition of the claim of the workers to representation on works organisations and to participation in the benefits resulting from disciplined effort.

The Organisation of Research

As was pointed out last year, the one-time gap between academic and technical research is closing up, and there is increasing recognition of the unity of research, the main difference between various branches being one not so much of kind or even of aim, but of range and distance, whether results are required quickly on a specific point or whether a field is being thoroughly surveyed to increase knowledge with an eye on the future rather than the immediate present. The universities, the various associations under the Department of Scientific and Industrial Research, and the research departments of individual firms and companies each have their functions. The past year has seen a cementing of relationships, academic research being subsidised by industry, and the various associations drawing ever closer to the chemical enterprises whose problems they are investigating. The development of the School of Chemical Engineering at University College, London, and the formation by Imperial Chemical Industries of a research committee, on which a number of distin-

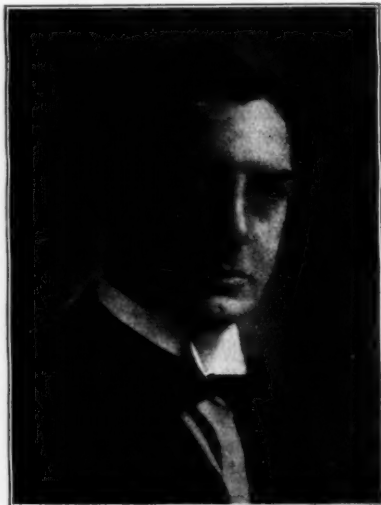
guished university professors will sit, are signs of a healthy movement. It is notorious that much of the research work carried out in industry has been very costly, and the Government is itself spending large and increasing sums on research associations, concerning which some stocktaking will one day be advisable. Anything which makes for economy without loss of efficiency is to be welcomed.

In yet another direction has progress been made, namely, with regard to standardisation in such matters as engineering parts, methods of analysis, particularly with regard to coal, and the fixing of international standards for dyed textiles.

Chemical Trade in 1927

Turning to details, the newer methods of manufacture referred to last year and the desire to avoid waste have resulted in a further cutting down of costs, and the selling prices of heavy and fine chemicals, of solvents and of raw materials have been reduced. Competition for world trade is very marked, particularly on the part of the United States, of Germany, and of Italy. To meet this successfully, there should be a reduction in the burden of local and national taxation, which is pressing more hardly on us than on our competitors. Economies can and must be accomplished.

In spite of this handicap, trade over 1927 has been fairly good at home, and exports, as in the case of synthetic nitrogen compounds, have increased. Trade has been much helped by the remarkable development of some relatively new industries, such as that of artificial silk, this industry now being



SIR WILLIAM ALEXANDER, M.P.

one of the chief home consumers of heavy chemicals and of solvents. There has been an increase in the home production of organic solvents, but this field is capable of much wider developments. The Motor Show at Olympia was a demonstration of the way in which cellulose products are replacing oil paints, and of the increasing use of artificial leather.

There has been a considerable expansion in the manufacture of synthetic nitrogen products, probably the most interesting development being the placing on the market of new nitrogenous fertilisers. In spite of this general world expansion, it is interesting to note that the exports of nitre from Chile are maintained. With regard to dyestuffs, better colours with a wider range of shades have become available for leather and rubber, and organic colour lakes are finding wider use in the paint and varnish industry.

Among heavy chemicals, there has been a shrinkage in the demand for sulphuric acid, but there has been some revival due to the demands of oil refineries. It is interesting to note the increasing use of brimstone as against pyrites. The chlorine

and alkali industries have profited from the increasing demands of the artificial silk and paper and pulp industries. The larger production of hydrogen and the use made of the inert gases, such as argon and neon, are to be mentioned. There are directions in which progress appears to be too slow, such as the production of films, of synthetic resins, and the use of sodium silicate.

Finally, very definite progress has been made, largely by individual firms, towards a better use of coal by some form of pre-treatment. Oil from coal is not now the hopeless proposition it once seemed to be, and the recognition of the new values of low-temperature coke as fuel may lead to important changes in factories and in mines. An increasing use of tar is to be noted, and its production may well some day be looked upon as a chief object rather than a by-product of the carbonisation of coal.

In conclusion, the prospects for 1928, given a continuance of industrial peace, are such as to warrant a feeling of optimism.

Recent Progress in Metallurgy

By Sir Robert Hadfield, F.R.S.

In this review of recent progress in metallurgy, Sir Robert Hadfield, the head of the great Sheffield steel firm, refers to the post-war developments in steel alloys and emphasises the importance of studies in molecular structure and properties as the key to future progress.

PROGRESS in metallurgy is continuous, and it is not easy to divide its development into periods coinciding with calendar years. As you are kind enough to ask me to send a communication on its trend during the last twelve months, I propose to refer briefly to some of the lines of investigation which, though not all of them are developed commercially at the present time, may contain the possibilities of important future practical application.

In my recent article in *The Times Trade and Engineering Supplement*, entitled "Modern Steel Production," I indicated the general lines of development and the present position of the different processes of steel production, and endeavoured to show how improved metallurgical chemistry had played its part in their development. The importance of the knowledge derived from a closer study of slag reactions needs no emphasis, but this knowledge develops slowly rather than by sudden outstanding discoveries. Nevertheless, the progress is real, and each decade the term "quality" of steel is becoming less mysterious and more subject to scientific control.

The most important post-war development of alloy steels is, no doubt, that associated with the nickel chromium type, namely, those exhibiting remarkable resistance to corrosive reagents, oxidation, and the attack of hot gases. During the past year the properties of such steels have become better known, and, where they exist, naturally also their shortcomings. Research on this subject is now being carried on extensively in all the industrial countries, and affords an excellent example of the friendly international competition of scientific workers, for attention has been called to new steels in this group with additional useful properties, first in one country and then in another.

The contribution of my own firm in this direction may, perhaps, be worthy of mention. Not only are our "Era/HR" steels initiating as it were a new class of engineering at high temperatures, but also in the chemical industry "Era/CR" corrosion-resisting steels are meeting with numerous practical applications. The successful production of sheets as large as 20 ft. in length by 5 ft. in breadth and of various thicknesses, also of hot and cold drawn tubes, has contributed materially towards that end.

It may also be interesting to record the increasing industrial

application of a type of steel which I investigated many years ago, in connection with my researches resulting in the invention of manganese steel, namely, a medium hard steel with from 1½ per cent. to 2 per cent. manganese. In America and elsewhere this type is meeting with increased application for rails and other parts subject to wear and severe stresses.

Progress of Scientific Investigation

Turning now to scientific investigations calculated to throw light on the fundamental properties of steels, the work of Mr. Sykes in America, showing that the hardness of tool steel can be obtained in iron-tungsten and -molybdenum alloys containing little or no carbon, is well worthy of mention. The work seems to be connected with the recognised explanation of the age-hardening of some non-ferrous alloys, and would appear to support recent theories of the interference-to-slip theory of hardness.

The mechanical and physical properties of materials must, of course, be eventually based on their molecular properties and structure, and important contributions, not only to our theoretical knowledge, but likely to be of practical value in the use of metals, are being made by the newer methods of X-ray analysis.

Those of us who have heard or read Sir William Bragg's interesting "Thomas Hawksley" lecture on this subject have appreciated the valuable aid which this method of research is bringing to our study of the metals with which we work or which we use. As has often been

noticed, studies on the "border-line" between metallurgy and other sciences often produce interesting and useful results, and microscopy has proved another aid to metallurgical advance.

In this connection reference should be made to the important work carried out at high magnification, largely originating in the work presented by myself and Mr. T. G. Elliot, F.I.C., to the Faraday Society in January, 1920, on "Photomicrographs of steel and iron sections at high magnification." This has been further followed up by Mr. Lucas and others, all helping to throw light on dark corners in our knowledge of the structure of metals and alloys. Application of ultra-violet illumination in metallography may also give us additional information on this important subject.



SIR ROBERT HADFIELD, F.R.S.

Developments at Billingham in 1927

By Lt.-Col. G. P. Pollitt, D.S.O., Ph.D., M.Sc.

Lt.-Col. Pollitt, who has played such a great part in the organisation and development of the great synthetic nitrogen works at Billingham-on-Tees, emphasises in this sketch of the enterprise during 1927 the great efforts continuously called for in research, design, and construction, and the remarkable service of scientific instruments built up for recording and controlling plant conditions.

It is now four years since the first ammonium sulphate from synthetic ammonia was produced at Billingham. Synthetic Ammonia and Nitrates, a subsidiary of Brunner, Mond and Co., Ltd., and now a part of Imperial Chemical Industries, Ltd., had taken over from the Government a site on the lower Tees designed for a nitrogen factory, and had erected there first laboratories and then a full scale plant for the production of 30 tons of ammonia or 120 tons of sulphate daily. On Christmas Day of 1924 the first ammonia was made. Since then the output has been steadily increased, partly by extensions, and partly by improvements in the process, so that each year has marked a notable increase of production over the previous year, and the rate of output is now equivalent to about 70 tons of ammonia a day.

In the past year, several new products have been manufactured, particularly ammonium nitrate, ammonium bicarbonate, anhydrous ammonia and nitro-chalk. Some sodium nitrite and sodium nitrate have also been made, and in the list of finished products must also be included precipitated chalk, which is a by-product in the manufacture of sulphate and is sold for agricultural and industrial purposes.

The Billingham Process

The production of ammonia is carried out by a modification of the Haber-Bosch process, which was developed in Germany just before the war. The ultimate raw materials are air, water and coal only: water gas is produced, and its content of carbon monoxide converted catalytically with steam to hydrogen. The gas is compressed and purified, leaving finally a mixture containing three volumes of hydrogen to one of nitrogen, and these gases combine directly in contact with a catalyst maintained at high pressure, and a relatively high temperature. The ammonia is dissolved in water, and combined with a portion of the carbon dioxide removed in the previous purification processes, and the ammonium carbonate formed reacts with anhydrite (of which there is a large deposit some 700 feet below the site of the works) to produce ammonium sulphate and chalk.

Nitric acid and its derivatives are produced by catalytic oxidation of ammonia gas with air and absorption of the oxides of nitrogen. The production of ammonium bicarbonate and anhydrous ammonia are, of course, straightforward processes.

Simultaneously with the developments already described, a further unit has been nearly completed during the past year, and will shortly start production. Its capacity will be equivalent to 165 tons of ammonia a day, combined as sulphate and other products. This unit includes also a plant for the production of methanol from water-gas by a high pressure catalytic process, very similar to that involved in the synthesis of ammonia. It is intended to continue the expansion of the works at Billingham by the immediate erection of further units, which will produce phosphate and other fertilisers in addition to ammonium sulphate.

Research, Design and Construction

These developments have called for great efforts in research, design and construction, and for a large increase of personnel. Problems connected with the improvement of running plants are attacked side by side with those involved in the starting up of new plant and the design and erection of future units.

On the research side, it has been necessary to provide one extension of the laboratories after another in quick succession, and there has been a continual influx of staff to deal with new problems. The chemical routine work increases also, but remains a comparatively small fraction of the whole. The greater part of the chemical investigations with which Billingham is concerned deal with physical chemistry, notably with equilibria, reaction velocities, catalysis and thermodynamic problems in general. A large number of experiments are carried out on corrosion, and work is always being done upon engineering and physical problems.

A particularly important group of physical problems is associated with the instrument service. The plants at Billingham are provided with instruments sufficient to determine the volume and the physical and chemical condition of every gas or liquid-stream at any point and any time. A large capital expenditure is, of course, needed to achieve this result, but the cost is soon repaid by the complete control which the instruments afford, by the speed with which they enable troubles to be diagnosed, and by the suggestions for the improvement of plant which study of their records continually suggests. Again, though much of the time of operatives is spent in watching instruments, the latter are, paradoxically, labour-saving devices. A proportion of the instruments not only record, but control conditions on a plant. Generally speaking, the instrument service reduces plant control to the simplest quantitative terms.

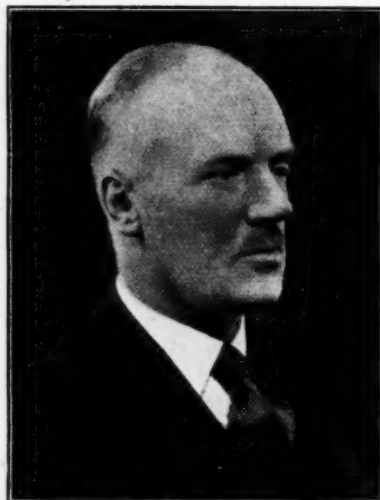
The Billingham research department is now also in close touch with the staff of Nitram, Ltd., whose agricultural research station at Jealott's Hill, near Maidenhead, will very shortly begin work. Research on fertilisers will be continued there from the point where it is left off at Billingham. One important problem, which has already had much attention in trials carried out at other farms in Great Britain and Ireland, is that of the intensive cultivation of young grass with the help of nitrogenous fertilisers in such a way as to produce a herbage rich in proteins and capable of supporting a much increased stock.

A New Industrial Community

The appearance of Billingham has been radically altered in the past year by the addition of the buildings for the new unit, which are now conspicuous landmarks on the level countryside. The permanent offices of the firm have also been completed and occupied during this year, and in the same period over two hundred houses have been erected for the firm's employees. The village, which was a very small one five years ago, is becoming a small town. Synthetic Ammonia and Nitrates, Ltd., are providing also new playing fields and tennis courts for their workmen, and levelling work for this is now proceeding.

Caledon Dyes for Concrete

CALEDON colours (manufactured by Scottish Dyes, Ltd.) have been prepared in special form for colouring concrete. With these it is merely necessary to mix the colour with the gauging water and then the cement and the aggregate in the usual way. It is also possible to apply these concrete colours in the form of washes, the colour merely being diluted with water. These colours are known as "Caledon Dyecretes."



LT.-COL. G. P. POLLITT

Chemical Engineering Developments in 1927

By Sydney J. Tungay, M.I.Chem.E.

Mr. S. J. Tungay, an authority on alloys and one of the earliest workers for the recognition of chemical engineering as a distinct branch of the profession, indicates the vital part that metallurgists and chemical engineers now play in modern chemical plant design and construction.

AN outstanding feature of the industrial progress of the last half century is the importance of the chemical industry, not only in this country, but among all industrial nations—and post-war achievements in connection with chemical industry and chemical engineering are as remarkable as the advance and progress in any other branch of industry, if, indeed, they are not more so.

It is, indeed, noticeable that the majority of the industries to-day depend to a very considerable extent upon the chemical manufacturer; and he in turn is dependent upon the advance in chemical engineering for the economical production of his output, and the satisfactory and economic working of his process.

The past year has shown very considerable progress in chemical engineering, and this progress is in direct ratio to the more acute competition experienced by the chemical industries.

The old adage to the effect that necessity is the mother of invention was never more truly applied than in the relation of chemical engineering to that of the chemical industries.

Chemical Engineering in Textiles

The contribution made by chemical engineering to the textile industry has been noticeable in connection with the artificial silk installations which have been developed so recently in this country, as well as abroad; calling continually for soundly-constructed plant for the handling of acids or alkalis, and for intricate machinery for the formation of a chemical compound into a material suited for the textile industries.

All the processes involving pumping, filtration, dissolving, drying, and refrigerating have called into operation for this particular line of industry the best research and experience of the chemical engineer.

Chemical Engineering in Allied Industries

Only a year ago, at the Chemical Congress in London, it was made plain that a large number of industries, not hitherto employing chemists, could be developed and improved to a great extent by the appointment of a suitably-equipped chemist to deal with their class of manufacture; and this has brought in its train the application of chemical engineering science and chemical engineering brains to the development and perfecting of satisfactory plant and equipment for varied industries.

It is recognised that no longer will the old rule of thumb process which pertained one or two decades ago survive in these days of keener competition. Old processes must be scrapped, the latest methods and research must be applied to our manufacturing processes if we are to compete in both maintaining our home trade and securing an adequate proportion of exports abroad.

Chemical Engineering and Metallurgy

Another direction in which considerable advance has been effected in this country is in the research and development in connection with corrosion resisting material as applied to chemical engineering practice. One has only to peruse the pages of the metallurgical numbers of this journal during the last twelve months, in order to ascertain how alert our metallurgists and chemical engineers have been on the subject of acid resisting metals and corrosion resisting materials generally. Numerous valuable publications in this connection have been issued. We are holding our own with acid resisting steels and irons, with research work on acid resisting lead, with the development of ceramic materials of

such kinds as our chemical manufacturers were inclined to think formerly could only be produced by the continental manufacturer.

Further, among metallurgical developments, the increased utilisation of nickel and nickel alloys, such as nickel chromium, copper nickel, or nickel-copper-silicon combinations, all have made big advances recently, and form a group of metals used more and more extensively by chemical engineers for the construction of chemical plant.

Achievements in this direction have given us some metal alloys extremely resistant to high temperatures, highly resistant to acid corrosion, and of great tensile strength, which do not easily break down under the action of heat or corrosives.

The Heavy Chemical Industries

Again, some of the best chemical engineering practice has been brought to bear in connection with the heavy chemical industries, even in connection with sulphuric acid manufacturing plant, regarding which we were supposed to have heard almost the last word during the war period; numerous advances have been made in the direction of more intensive production from chamber systems, the application of water spray, of weak acid spray, and the turbo-disperser system of weak acid in chambers, which has proved itself a very decided economy, alike improving the capacity of the chambers and economising the nitre consumption.

Modern Drying Methods

One could hardly ponder over chemical engineering progress and methods of handling material without saying something in connection with recent methods of drying, and the system of spray drying which has recently been developed. The Kestner spray dryer has awakened much interest among chemical engineers, and seems likely to solve many difficulties in connection with drying where a finely powdered final product is required.

Spray drying methods are still in their infancy, but already show they are going to prove a valuable means of drying and production of many chemicals in finely powdered condition. We believe there are possibilities of wide future development.

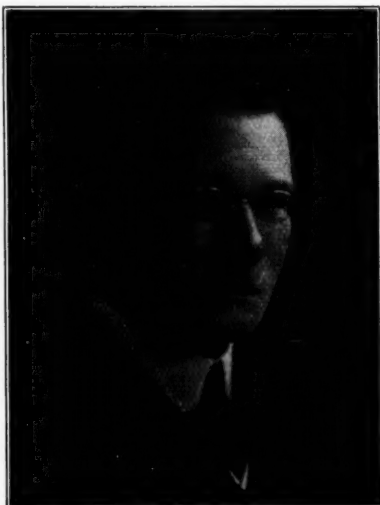
Chemical Engineering in Synthetic Products

In the synthetic production of nitrates and nitric acid our chemical engineers in this country have been very wide-awake, causing a big change-over in some of our staple chemical industries where nitric acid is a primary consideration, and where ammonium sulphate has formerly been a regular production.

Whilst the advance in science and skill of the chemist and chemical engineer will often cause little short of a revolution in some industries, progress must needs be maintained. We as an industrial nation are compelled to hold our own in the face of all comers. This fact alone is a sufficient incentive to draw forth our best efforts, both in science and industry. Continental and American practice do not lag behind in the development of new processes and new methods, and it is incumbent on British chemical engineers to see that they do their part in the maintenance of British chemical industry.

Beet Sugar Industry

In connection with the design and installation of plant for the production of beet sugar, our chemical engineers in this country are now keeping pace with the requirements of this



MR. S. J. TUNGAY.

industry and its development. Only recently the Chemical Engineering Group of the Society of Chemical Industry, held a session dealing with this particular class of equipment, and within this last month or so a very detailed report has been issued by Dr. B. J. Owen, Director of the Institute of Agricultural Engineering, Oxford, dealing with the desiccation of sugar beet and the extraction of sugar, together with information on the treatment of sugar beet effluents.

This latter point in connection with beet sugar manufacture is one which demands, and is now receiving, the closest attention of chemical engineers.

It would require a very much longer article than the present to deal effectively with recent improvements in connection with general chemical plant, with evaporation, filtration, the recovery of waste products, or the more modern methods of oil refining, and the Cross cracking process. Matters pertaining to transport and handling of raw materials are receiving at the hands of the chemical engineer more close attention than ever before.

It is recognised that for economic production in the chemical industry, newer and more efficient method of transport and automatic handling is necessary, both as regards raw material and finished products. No longer can high-priced hand labour be utilised for many chemical products, but the methods of loading, conveying, handling, and storing in the factory itself must be made as automatic as possible, so as to decrease production costs. Special regard has to be paid to the handling and transport of dangerous or corrosive material and chemicals needing exceptional handling.

High Pressures in Chemical Industries

Much, too, might be said on the point of utilisation of higher pressures and the improvements continually being effected in plant to deal with high pressure air, gases, and steam.

We have recently discussed at a large progressive chemical works in the London area the adoption of extremely high pressure steam, the use of turbines, the adaptation of the exhaust from these for heating in process work, and the lower pressures for heating factory premises and the ultimate pre-heating of boiler feed water so as to maintain the utmost efficiency in fuel consumption throughout the system. High pressures have undoubtedly come to stay, and it is the realm of the chemical engineer to design and construct plant capable of dealing with them.

The time is fast approaching when the industrialist and the manufacturer, even outside ordinarily recognised chemical industries, no longer queries whether he can do without a chemist or a chemical engineer. He now realises that he needs the best brains and skill that can be put into his plant, if that plant is to produce dividends.

The British chemical industry has thoroughly representative men dealing with chemical engineering problems, and these again unite into societies, such as the Institution of Chemical Engineers, the Chemical Engineering Group of the Society of Chemical Industry, the British Chemical Plant Manufacturers' Association, whilst the transactions of other societies, such as the Faraday Society and the Institute of Metals, frequently provide us with valuable facts in connection with metallurgical problems which have to be studied by the chemical engineer.

The Nitrogen Industry in 1927

By E. B. Maxted, D.Sc., Ph.D.

For the eighth year in succession, Dr. E. B. Maxted, one of the early researchers and experimenters in the synthetic nitrogen field, performs the useful service of reviewing the principal technical developments of the year. While he recognises the immense possibilities before the synthetic industry, he expresses the view that natural nitrates will continue to hold their own for many years to come.

SINCE the first of these annual reports, eight years ago, the position of the fixed nitrogen industry has undergone many fundamental changes. At that time, the industrial synthesis of ammonia, in countries other than Germany, was in its infancy. To-day, the capacity of the Billingham factory of Synthetic Ammonia and Nitrates, Ltd., is, according to figures published during the past year, of the order of 20,000 tons of ammonia per annum, and an extension to nearly three times this output is planned; further, a number of important plants are in operation in the United States, France, and elsewhere, in addition to the original works of the Badische Co. at Oppau and Merseburg. It has been estimated in the report of the British Sulphate of Ammonia Federation that the world production of fixed nitrogen is now about 2,000,000 tons a year, this being considerably in excess of the present consumption. In spite of this, and of the corresponding drop in prices, the general condition of the fixed nitrogen industry is decidedly active; on many sides extensions are being made and new works erected, the view being taken that the potential demand for fixed nitrogen, especially for agricultural purposes, greatly exceeds the actual annual purchases which are now being made, and that the key to even greater useful production lies in the creation and development of new markets, especially in the Colonies. In this connection, an address by Sir Alfred Mond (1) on chemical fertilisers and the empire is of special interest. The future of any industry is largely a matter of confidence and of foresight; and the

manner in which the synthesis of ammonia, in spite of unparallelled technical difficulties, has justified the expectations of ten years ago may well warrant the existing feeling of confidence in still further extensions, notwithstanding the present anomalous ratio between production and consumption.

From a technical standpoint, probably one of the principal changes since the early days of the synthesis has been the seemingly permanent increase in the cost of fuel. Since the cost of hydrogen is the most important item in the manufacture of ammonia, many of the older views on the relative economy of hydrogen from fuel and that prepared by electro-lysis have had to be revised. Although it is still the general practice to use hydrogen made by the so-called continuous water gas process, a small but increasing number of plants, particularly those of small size, employ electrolytic hydrogen. Attention may also be drawn to the recent agreement between the Norsk-Hydro Company and the I.G. Farbenindustrie and to the extension in the use of electrolytic hydrogen for ammonia which seems to be foreshadowed thereby.

The natural nitrate industry has on the whole been inactive; although a considerable number of patents have been published, particularly from German sources, dealing with improved methods of extracting caliche and with the treatment of relatively poor nitrate deposits. The price of nitrogen from Chilean nitrate is now higher than that fixed synthetically; but, given the proper technical and fiscal conditions, natural nitrates should continue to hold their own with the synthetic product for many



DR. E. B. MAXTED

(1) THE CHEMICAL AGE, Vol. XVII, p. 411.

years to come, all the more since the exhaustion of the nitre beds is by no means so near as was at one time thought.

Among the papers and patents published during the year, the following may be mentioned:—

Synthesis of Ammonia

G. P. Pollitt (2) has published an illustrated paper of great interest dealing with the Billingham factory and especially with the difficulties which had to be overcome in its technical development. The description is general only; but the photographs show clearly the magnitude of the task which has already been accomplished. Attention may also be drawn to a particularly full description of the plants at Oppau and Merseburg (3). The Oppau installation has a capacity of 100,000 tons of fixed nitrogen per annum, that at Merseburg having four times this capacity. The source of hydrogen at Oppau consists of 5-6 million cubic feet of water gas a day, which is manufactured by the ordinary intermittent process and converted into hydrogen by interaction with steam. Traces of carbon monoxide are removed by treatment with copper salts under pressure. In preparing ammonium sulphate from the ammonia produced, a process is used involving the interaction of calcium sulphate, carbon dioxide, water and ammonia, the use of free sulphuric acid being thus avoided. A somewhat similar process to this is also employed at Billingham.

Purification of Gases

Several patents for the purification of the gases for the synthesis of ammonia may be cited. K. Müller (4) treats the mixture of nitrogen and hydrogen with sodium hydride at 200° C. under pressure, while, according to the procedure suggested by the Norsk Hydro-Elektrisk Kvaelfabriksselskab (5), the gases are passed through liquid ammonia containing calcium nitrate or other hygroscopic salts—for instance, ammonium nitrate, metallic cyanides or chlorides—which combine with the impurities present. These salts may either be in solution or in suspension; and the method is obviously destined for use as a final process of purification which shall follow the more usual methods. In order to remove carbon dioxide, water under pressure is usually employed. K. E. G. Clark and H. J. Krase (6) propose to use a similar mixture—namely, liquid ammonia together with ammonium nitrate, for the removal also of carbon dioxide from the gases taken for the synthesis.

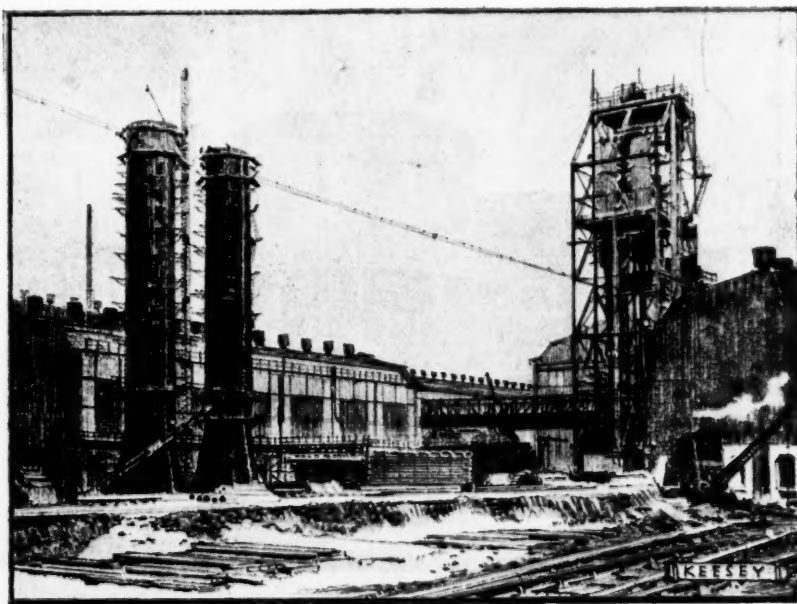
Catalysts

Catalysts employed for the manufacture of ammonia almost always contain an iron base, the activity of which is raised by promoters. As a variation in the production of fused iron oxide by burning iron in oxygen, L. H. Great-house (7) mixes ferric oxide with a small proportion of aluminium powder, such that, when ignited as in the thermite process, fusion without substantial reduction occurs. The

oxide is broken up and reduced with hydrogen in the usual way.

It is well known that, in many reactions, the activity of a reduced metallic catalyst varies with the nature of the oxide from which it is made. This effect has now been observed with iron in the synthesis of ammonia. J. A. Almquist and E. D. Crittenden (8) find that a more active catalyst is prepared by reducing ferrous-ferric oxide, Fe_3O_4 , than from other oxides of iron; indeed, if ferrous oxide is present in addition, the activity of the reduced iron decreases proportionately. The above authors also state that potassium oxide lowers the activity of an iron catalyst unless an infusible oxide, such as silica or alumina, is also present. Additional information on the activity of iron, nickel, cobalt, tungsten and molybdenum as catalysts has been published by A. T. Larson and A. P. Brooks (9). Of these metals, iron is the most active; but its activity decreases rapidly if the catalyst is used at a relatively high temperature. Nickel and cobalt possess a low activity only, and, as has been found by other workers, effective catalysts may be made by combining iron with molybdenum.

A specially active catalyst consists of 96 per cent. iron, 3 per cent. of alumina and 1 per cent. of potash, this type being, of course, not new. Of other catalysts, iron carbide may be mentioned. K. Müller (10) states that this is active below 450° C., and that it may be further activated in the usual way, particularly by metallic oxides in conjunction with potassium compounds. F. Uhde (11) suggests the preparation of a catalyst by adding potassium ferrocyanide to aluminium chloride, the mixture being evaporated to dryness and reduced with hydrogen at 400 to 450° C.



INSIDE THE BILLINGHAM WORKS.

A novel procedure is described in a patent granted to the I.G. Farbenindustrie A.G. (12), according to which a catalyst in the form of dust is circulated with the gases and subsequently removed. The use of larger particles, which are whirled into the reaction space by the current of gas is also described. At first sight, it would not appear that the variation possesses advantages over the usual method of employing a stationary catalyst.

Ammonia furnaces have now become more or less standardised; and, where the process is operated autothermally, their design is very simple. Claude (13) has described a type of synthesising vessel consisting of an outer pressure-resisting shell containing an inner vessel in which the catalyst is placed. The space between these vessels is cooled by circulating gas, as is the usual practice; and the heat insulating material round the catalyst space is varied in thickness in such a way that this increases progressively from the gas inlet towards the end connected with the gas outlet. In a further specification (14), the catalyst is cooled by circulating the gas, immediately before reaction, through the catalyst bed, the gas

(2) *J. Soc. Chem. Ind.*, 1927, 46, 2917.

(3) *THE CHEMICAL AGE*, Vol. XVI, p. 330.

(4) *Brit. Pat.* 261,388; *THE CHEMICAL AGE*, Vol. XVI, p. 91.

(5) *Brit. Pat.* 266,689; *THE CHEMICAL AGE*, Vol. XVI, p. 449.

(6) *J. Ind. & Eng. Chem.*, 1927, 19, 205.

(7) *U.S. Pat.* 1,618,004.

(8) *J. Ind. & Eng. Chem.*, 1926, 18, 1307.

(9) *J. Ind. & Eng. Chem.*, 1926, 18, 1305.

(10) *Brit. Pat.* 271,482; *THE CHEMICAL AGE*, Vol. XVII, p. 115.

(11) *Brit. Pat.* 273,735; *THE CHEMICAL AGE*, Vol. XVII, p. 242.

(12) *Brit. Pat.* 274,904; *THE CHEMICAL AGE*, Vol. XVII, p. 311.

(13) *Brit. Pat.* 268,721; *THE CHEMICAL AGE*, Vol. XVI, p. 558.

(14) *Brit. Pat.* 268,722; *THE CHEMICAL AGE*, Vol. XVI, p. 558.

being thus pre-heated; and a furnace has also been described in which, in order to render the temperature more uniform, gas from the hotter parts of the catalyst is circulated in indirect contact with the cooler portions before being allowed once more to pass into direct contact with the catalyst. (15).

Ammonium Salts

It has already been mentioned that the usual practice in manufacturing ammonium sulphate from synthetic ammonia consists in allowing the gas to react with calcium sulphate in the presence of carbon dioxide. The Elektrizitaetswerk Lonza (16) proposes a slight variation according to which an excess of ammonia is added, the greater part of the ammonium sulphate being thus precipitated and removed. F. Siemens A.-G. and H. Bähr (17) have described a method for the production of ammonium sulphate and sulphite from gases containing small percentages of hydrogen sulphide and ammonia, together with oxygen, by passage at 300° C. over a catalyst consisting of iron, nickel, or cobalt mixed with an oxygen-activating metal such as vanadium. The temperature is not high enough to oxidise other combustible gases; but if the catalyst is electrically heated, a tarry deposit is likely to form, which may be removed by raising the temperature occasionally. The grey colour of commercial neutral ammonium sulphate from gas works is stated by A. Weindel (18) to be due to the presence of iron sulphide. Accordingly, the discolouration may be avoided by utilising ammonia gas which is free from hydrogen sulphide for neutralising the crude acid sulphate.

The production of tough fibrous

crystals of ammonium chloride, similar to those obtained by sublimation, is dealt with in a patent granted to J. W. Moore, W. G. Polack and The Castner-Kellner Alkali Co., Ltd. (19). Synthetic ammonia is allowed to react with gaseous hydrochloric acid at such a rate that a high reaction temperature is obtained.

Ammonium carbonate possesses a particular interest, since no extraneous acid, save the carbon dioxide produced in the manufacture of hydrogen by the continuous method, is required for its production. In order to manufacture this salt in a solid form, carbon dioxide, ammonia and a limited amount of water may be allowed to react (20); further, ammonium carbonate or carbamate may, according to a process proposed by the I.G. Farbenindustrie (21) be obtained in a compact form by sublimation under pressure. For somewhat similar methods to the above, reference may also be made to Brit. Pat. 275,459.

Nitric Acid and Nitrates

Interesting work on the efficiency of cobalt as a catalyst for the oxidation of ammonia has been published by W. W.

Scott and W. D. Leech (22). Cobalt oxide alone is not specially efficient; but its activity may be increased considerably by adding bismuth or aluminium oxides, normal yields of nitric acid (90 per cent. and over, as with other catalysts) being then obtained. The promotion of an iron catalyst with bismuth in a similar manner, is well known. Two variations in procedure with platinum gauze catalysts have also been described. N. Caro and R. Frank (23) pass the gases, before reaction, through a layer of water immediately preceding the catalyst, for instance, a few centimetres below the platinum gauze. The heat of reaction is thus absorbed. I. W. Cederberg (24) describes a type of converter consisting of a narrow reaction space, which is cooled by water and which contains a platinum net, the construction being specially suitable for use with oxygen.

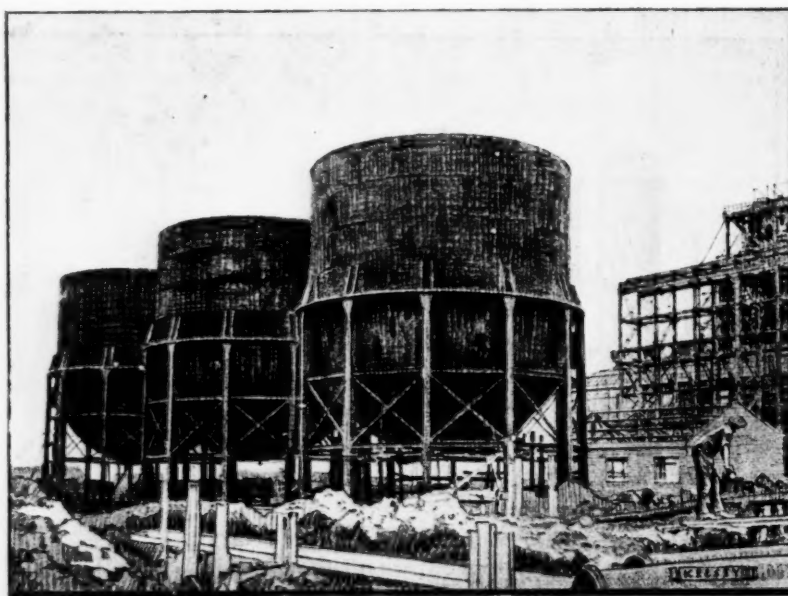
Oxides of nitrogen derived from ammonia are now cheaper than those from the Chile nitrate, and it is becoming an increasing practice to employ ammonia for this purpose in chambers for the manufacture of sulphuric acid. Some notes

on this subject are contained in papers by C. L. Parsons (25) and by H. Killefer (26). A relatively high reaction temperature (slightly over 1,000° C.) is used in order to minimise the action of poisons; and the connections are either of aluminium or of chromium steel.

According to the method of absorption of oxides of nitrogen employed by Toniolo (27), the gases are passed into towers containing cooled water. A useful résumé of the advantages of cooling has now been published. *Inter alia*, cooling prevents the decom-

position of nitric acid by reaction with lower oxides of nitrogen, and it also induces a more rapid oxidation of nitric oxide. In place of circulating the gases and cooled absorbents in counter-current, greater efficiency and the necessity for less power for cooling is obtained if both fresh absorbent and gas be introduced at the top of each tower; and the temperature of the absorbing liquid should preferably be 0° C. or slightly above.

Passing to the manufacture of sodium nitrate, two patents of the I.G. Farbenindustrie (28) may be mentioned. According to the first of these, crude sodium nitrate is leached with a limited supply of water or of mother liquor at 15 to 30° C., in such a way that the greater part of the nitrate is dissolved, while a large proportion of the sodium sulphate and chloride remains. The solution is heated, used while hot to leach another charge of crude nitrate, cooled to recover the crystals, following which it is diluted and used for the extraction of a further portion of crude salt at room temperature. The second patent deals with the recovery of oxides of nitrogen from deposits poor in nitrate. These are heated to redness



SOME OF THE BILLINGHAM PLANT.

- (15) Brit. Pat. 275,592; THE CHEMICAL AGE, Vol. XVII, p. 331.
- (16) Swiss Pat. 114,699;
- (17) Brit. Pat. 268,024; THE CHEMICAL AGE, Vol. XVI, p. 428.
- (18) Brennstoff-Chemie, 1927, 8, 104; ex Brit. Chem. Abs., B, 1927, 363.
- (19) Brit. Pats. 273,093 and 274,263; THE CHEMICAL AGE, Vol. XVII, pp. 133 and 199.
- (20) Brit. Pat. 262,408, THE CHEMICAL AGE, Vol. XVI, p. 167.
- (21) Ger. Pat. 442,176.

- (22) J. Ind. & Eng. Chem., 1927, 19, 170.
- (23) Brit. Pat. 273,718; THE CHEMICAL AGE, Vol. XVII, p. 242.
- (24) Brit. Pat. 244,134.
- (25) J. Ind. & Eng. Chem., 1927, 19, 789.
- (26) J. Ind. & Eng. Chem., 1927, 19, 1153.
- (27) Chem. & Met. Eng., 1927, 34, 92. Brit. Pat. 267,721; THE CHEMICAL AGE, Vol. XVI, p. 401.
- (28) Brit. Pats. 266,735 and 266,744; THE CHEMICAL AGE, Vol. XVI, p. 486.

with a non-volatile acidic body, such as an acid silicate, when the nitrogen oxides are evolved.

In order to prevent the caking of ammonium nitrate on storage, precipitated di-calcium phosphate may be added, a mixed nitrogen phosphorus fertiliser being thus obtained (29). The addition of superphosphate is inadmissible, since oxides of nitrogen are evolved. It may be noted that, in the preparation of fertilisers containing phosphorus, nitrogen and potassium, ammonium nitrate, by itself, is to be avoided. A suitable mixture is, however, made by bringing together 30 per cent. of ammonium nitrate-sulphate, 20 per cent. of di-calcium phosphate and 50 per cent. of potash salts.

W. H. Bentley, B. Catlow and W. Blythe and Co., Ltd. (30), have published an interesting method for the preparation of lead nitrate. When lead is dissolved in nitric acid in the ordinary way, considerable loss of acid occurs through the evolution of oxides of nitrogen. If the metal, however, is heated in air, lead oxide is formed superficially, and this reacts rapidly with lead nitrate. In the process described, granular lead in an acid-proof basket is alternately exposed to air and lowered into lead nitrate solution, nitric acid being added to this in amount proportional to the lead dissolved.

Other Nitrogen Compounds

A further study of the formation of aluminium nitride from alumina, coke and nitrogen has been made by H. J. Krase, J. G. Thompson, and J. Y. Yee (31), iron being employed as a catalyst. To this end, bauxite, magnetite and coke were heated together in an electric furnace, nitrogen being subsequently admitted at atmospheric pressure. Small percentages of substances such as cryolite, calcium chloride or calcium fluoride facilitate the production of aluminium nitride in this way; indeed, conversion may, under favourable con-

ditions, be practically complete at 1200° C. This promoting effect of calcium chloride or fluoride is reminiscent of its action in the formation of cyanamide from calcium carbide and nitrogen.

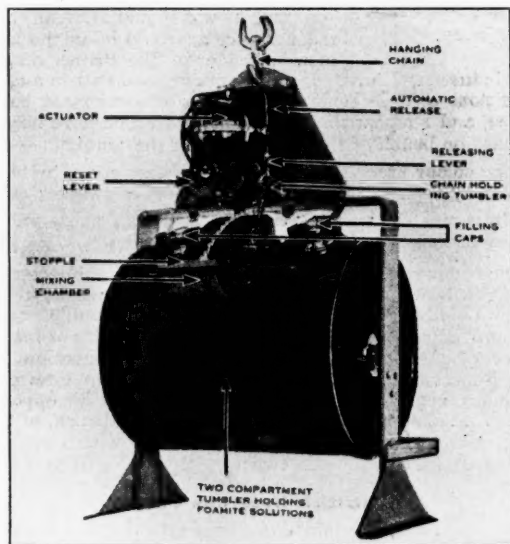
The Bucher process for the manufacture of cyanides has again received attention. In Brit. Pat. 265,993 a process is described in which coal or other carbonaceous matter is mixed with alkali and heated in internally fired drums, constructed in such a way as to prevent the charge from falling during rotation. The coked mass is stated to be very suitable for the production of cyanides. Iron, in the form of a complex salt, such as sodium ferrocyanide, is recommended as a catalyst for the synthesis of cyanides by this process, porous carbon being impregnated with a solution of this together with sodium carbonate (32).

Several patents deal with the preparation of hydrocyanic acid from formamide. According to a method protected by the I.G. Farbenindustrie (33), formamide, either alone or together with ammonium formate is passed at 400 to 900° C. over a dehydrating catalyst, such as alumina, the resulting gas being rapidly cooled, while, in another variation of the method, soda ash at 400° C. is used as the catalyst (34). Some of the hydrocyanic acid reacts with the soda, the remainder being obtained in the free state.

Finally, some mention may be made of stabilisers for hydrocyanic acid. Kieselguhr is sometimes used; but the mixture is liable to decompose. It has now been found that this decomposition may be prevented (35) if the porous absorbent is first treated with acid to remove free alkali. Further stabilisers for hydrocyanic acid are ethyl sulphate, aluminium chloride and other bodies, for a list of which reference may be made to British Patent 254,747.

An Automatic Foam Extinguisher

An automatic "Foamite" extinguisher, for protecting dip tanks, varnish kettles, open oil storage tanks, cleaning tubs, etc., against fire, is being marketed by Foamite Firefoam,



THE AUTOMATIC FIREFOAM EXTINGUISHER.

Ltd., of 55-57, Great Marlborough Street, London. The apparatus is 20 by 23 by 32 inches, has a capacity of 5 gallons each of Foamite "A" and "B" solutions, and discharges about 80 gallons of Firefoam. The two Foamite

solutions are held separately in a divided tumbler, and a ball and chain attached to the tumbler and hung on the releasing lever prevent the tumbler, which is set eccentrically on trunnions, rotating to its discharge position. An actuator attached to the release case is connected to the "Automatic" release by copper tubing. When a fire occurs, the rapid rise in temperature causes the air pressure in the actuator to increase. This pressure is transmitted to the release, whereupon the releasing lever drops the ball and chain and permits the tumbler to rotate to its discharge position. The release does not operate at a certain definite temperature, but depends for its operation upon a rate of rise of temperature. It is not necessary for the fire to burn long enough to heat the room to a certain temperature before the release operates. The apparatus (shown in the illustration) is known as model R T, and its automatic device operates in 10 seconds or less. The foam produced is sufficient to extinguish inflammable liquid surfaces of area up to 25-30 sq. ft. In a test, petrol and paraffin in a tank were ignited, the release operated in seven seconds, and the fire was completely extinguished in 45 seconds.

Leeds University Lectures on Fuel

IN connection with the work of the University of Leeds Department of Coal Gas and Fuel Industries with Metallurgy, arrangements have been made for the delivering, during the second term of the session, of special courses of evening lectures. A course of twelve lectures will be divided into two sections—carbonisation practice and gas purification practice. Mr. T. F. E. Rhead, Chief Chemist, City of Birmingham Gas Department, will take the former subject, and Mr. H. Hollings, Chief Gas Chemist, London Gas Light and Coke Company, the latter. Waste heat recovery in carbonisation industries will be dealt with in lectures by Dr. A. Parker, Research Chemist to the Joint Research Committee of the Institution of Gas Engineers and the University of Leeds; refractory materials by Professor J. W. Cobb; and metallurgy by Mr. P. F. Summers.

(29) Brit. Pat. 269,235; THE CHEMICAL AGE, Vol. XVI, p. 514.

(30) Brit. Pat. 268,104; THE CHEMICAL AGE, Vol. XVI, p. 428.

(31) J. Ind. & Eng. Chem., 1926, 18, 1287.

(32) Ger. Pat. 435,975.

(33) Brit. Pat. 261,559.

(34) Brit. Pat. 279,530; THE CHEMICAL AGE, Vol. XVII, p. 514.

(35) Brit. Pat. 271,236; THE CHEMICAL AGE, Vol. XVII, p. 12.

The Dyestuffs Situation: The Users' Point of View

By H. Sutcliffe Smith

(Chairman of the Colour Users' Association)

Continued attention to the price factor, the need of developing production and export, the demand for cheaper intermediates, the protection of users' interests in any international agreements, and the advantages of a British census of dyestuffs production—these are the chief points in this article by Mr. Sutcliffe Smith, who is supremely qualified to represent the dyestuff users' point of view.

A year ago you invited me to comment on the Dyestuffs situation from the point of view of the user, when I particularly emphasised the question of prices.

This question is still of vital importance, and the greatest concern of British users is that they shall obtain their dyewares at prices which will enable them to compete with other users in the world's markets. Recent negotiations undertaken by the users' representatives on the Dyestuffs Licensing Committee resulted in an arrangement whereby the factor employed in determining applications for licences on price grounds was reduced from $2\frac{1}{2}$ to 2 times the pre-war price. This is eminently satisfactory, and is indicative of the steady progress of the British dyemaking industry. The lower factor mentioned, which operated from September 1, 1927, gives British dyestuffs manufacturers protection to the extent of 100 per cent. on pre-war for the great majority of their colours, a figure which must be considered satisfactory, as the Board of Trade wholesale prices index figure is at the time of writing 141.4, and the British makers therefore enjoy considerable advantage over the general level of commodity prices as compared with pre-war standards. This, as I say, shows remarkable progress on the part of the British industry in getting down to a price level not exceeding double 1913 prices, and in some instances colours have been produced and sold at less than the protected figure.

Prices Dependent on Production and Export

Price reduction in the British industry depends upon two factors, these being production and export. The productive capacity of the works already established is greatly in excess of the home consumption, based on a maximum demand basis, and unless something approaching full production can be sold, the costs cannot be brought down to a minimum. There is cause for great satisfaction with the progress made by British makers in the home trade, but it is disturbing to find from the returns that the exports of dyestuffs obtained from coal tar, as furnished by the Board of Trade, are not upon a satisfactory basis.

Exports of dyestuffs obtained from coal tar:—

Year.	Weight. cwt.	Value. £
1913	48,673	177,246
1924	104,396	923,933
1925	104,161	847,639
1926	75,727	614,112

The total production of British dyestuffs in 1925, it has been stated, was 15,000 tons, and the import of dyestuffs obtained from coal tar for the same year was 2,000 tons, giving a total of 17,000 tons. If the home market only consumes approximately one-half of the potential British output an export market for at least 15,000 tons per annum must be created. The task before the British makers is a stupendous one—that of trebling their 1925 exports. How best to obtain the desired access to the world's markets is a matter for the dyemakers themselves, and should be approached vigorously, but the question of cost of production is one in which colour users are vitally interested, and in view of the tremendous sacrifices which they have made in order that the dyemaking

industry might be established in an unassailable position, I feel that they are entitled to make constructive suggestions for the lightening of our common burden.

Discussion has arisen on the question of the cost of intermediate products used in the manufacture of dyewares. I have personally made several inquiries into the costs of the raw materials in this country and on the continent, and have been struck by the wide variation between the prices continental makers pay compared with those which obtain in this country. In many cases the British maker pays considerably more for his intermediates than his continental competitor. This is not conducive to low-production costs here, and I trust that British makers of intermediates will approach the matter in a broad and generous spirit and reduce their prices wherever possible.

Dyestuffs Amalgamations

The amalgamation of dyemaking and chemical industries in this country with those on the Continent has been very much to the fore recently, and fears were constantly expressed that even the largest dyemaking concern in Great Britain would not be able to come to terms with any foreign makers on lines that would benefit the dyemakers and users in this country. It was thought that any agreement arrived at would be in the nature of a surrender of the British company

and industry. I have constantly maintained that in any such conditions or agreement the interests of users must be protected, and I repeat the main principles which have been put forward on behalf of the colour users of the country:—

1. The colour users must be assured of free access to the best quality and range of dyestuffs produced anywhere; and
2. Users must be on as favourable terms as regards prices as any of their world competitors.

The fusion of British dyemaking and chemical interests has, I believe, been a great step forward, and the whole trend of modern industry, particularly in America and Germany, has proved the formation of large combinations of interests to be of the utmost value in reducing production costs and improving marketing methods. Definite information is almost negligible, and I would welcome, at an opportune time, a statement of the position from the British interests concerned in any proposed amalgamation with continental organisations.

A British Dyestuffs Census

In conclusion, I should like to refer to another important matter from the point of view of the users. I consider it essential, bearing in mind the heavy contribution made by the colour users towards the cost of the establishment of the British dyemaking industry, that some means should be available for assessing the progress made by that industry. The late Lord Moulton declared that with the necessary protection, the industry should be able to withstand competition after five years. The colour users have borne their share of the burden for seven years already, with the prospect of a further three years of protection to the dyemakers under the Dyestuffs (Import Regulation) Act. Whilst it is possible to record great progress generally, sufficient information is not



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available to enable colour users to estimate whether that progress is commensurate with the sacrifice they have been called upon to make. I refer, of course, to the dearth of authoritative and detailed statistics of the production, imports and exports of dyestuffs of this country. I am aware that detailed information of imports and exports is collected by the Board of Trade, but it is not published in such detailed form as would enable the fullest use to be made of it. Further, even if it were so published it would not be of much value unless similar details were published of the British production. I must compare the position here with that which obtains in the United States of America. The U.S. Government publishes annually a most comprehensive and useful statistical volume, *Census of Dyes*, showing the production, imports and exports of the U.S.A., and also a great deal of information of a similar nature relating to other countries. Here is a useful field of activity for the Dyestuffs Industry Development Committee, and I hope that committee will be able to obtain and collate for the use of the industry generally the information necessary for the publication of such a valuable report as the *Census of Dyes*. I trust, therefore,

that everyone concerned will take a broad view and enable either that committee or some other body to perform an essential service to the industry.

Co-operation with Universities

For several years now at the annual meetings of the Colour Users' Association I have urged the vital importance of fundamental research and co-operation with the Universities, which might be lost sight of in the competitive field, and I have been supported in this plea by my friend, Professor Thorpe. There has been no definite organisation to bring manufacturers of dyestuffs and intermediates into touch with the work carried on in our University laboratories. It is, therefore, gratifying to me to notice from the Press that Sir Alfred Mond is taking steps to establish a closer liaison between the great technical industries of which he is the head and the Universities by means of an influential committee of experts, and it is further pleasing to note that a step has already been made by the appointment of Professor Williams, who, with his previous industrial training and his later University experience, will be a valuable acquisition to the industrial field.

The Fine Chemical Industry in 1927: Steady Progress

By C. A. Hill, B.Sc., F.I.C.

(Chairman of the Association of British Chemical Manufacturers.)

Sound consolidation and steady progress are the main features of the fine chemical industry during the year, according to the author, who is Chairman of British Drug Houses, Ltd. Recent indications point to a steady improvement in trade, and the outlook is described as quite hopeful and promising.

LEADING industrialists state plainly that trade conditions generally—that is, apart from strikes and their immediate influences—have been worse during 1927 than those prevailing during 1926. Notwithstanding the security afforded by industrial peace, the purchasing capacity of the world does not seem to have responded as might have been expected. Although during the first quarter of the year business was brisk—this being due, partly at least, to the reaction consequent on the settlement of the coal strike—business during the second and third quarters was flat and depressed. It is hopeful, however, to observe that during the concluding months of the year signs of a steady improvement have been evident, a prospect which is more encouraging than that which arises from sudden spurts of prosperity, which experience has shown are frequently ephemeral and of short duration.

The available figures relating to exports and imports of fine chemicals during the period under review are necessarily incomplete, but so far as can be ascertained they go to show that the exportation of fine chemicals during the year has been equivalent to that of 1925 and 1926; while imports, so far as can be determined at present, appear to be somewhat heavier than in previous years. A recent publication in a contemporary journal gives the total value of Great Britain's annual output of fine chemicals as being between £2,500,000 and £3,000,000 sterling, of which about £500,000 is exported. Market prices have been generally steadier, with a slight tendency to an all-round reduction.

Development and Progress

The year 1927 can show development and progress in several branches of manufacture in the fine chemical industry. In connection with the fine chemical products which were made in large quantities during the last year—what may be termed the "heavier" fine chemicals, such as organic solvents of a special character and so forth—makers report that progress in 1927 has consisted chiefly of translation to the large scale from the laboratory scale of the manufacture of new products. This work is at present in the transitional stage and is not yet complete. The manufacture of the newer products such

as esters and hydrogenated hydrocarbons used for lacquer solvents is developing rapidly, in spite of which increased production, however, the home manufacture is unable to keep pace with the increased demand.

The wide extent of the rubber industry gives importance to the manufacture of rubber chemicals. A considerable number of these chemicals are used as

"accelerators," one of the most striking applications of these compounds being their use in low-temperature vulcanisation, which has proved of the greatest advantage to the rubber industry. The British manufacture of photographic chemicals, the chief of which are used in the manufacture of sensitisers and developers, is maintaining its position.

In the manufacture of rare earths, despite the fact that import statistics show that 50,000 lb. of thorium nitrate was imported into Great Britain during 1927, of which 41,000 lb. came from Germany, the British market for thorium is to-day the most important, and Continental thorium makers have made great efforts to retain it. One British firm of thorium makers is now making 35,000 kilos. of thorium nitrate per annum, and is also supplying all the cerium compounds required for glass, photography, medicine, and other purposes.

Pharmaceuticals

Perhaps, however, the greatest progressive activity in fine chemical production is to be reported in the pharmaceutical group, which is well known to be by far the largest as regards number and range.

An important addition in the field of alkaloid manufacture is the production of ephedrine, which has now been put on the market by three leading firms of fine chemical manufacturers. Ephedrine is extracted from the Chinese plant *Ma Huang*, and is an effective remedy in cases of asthma and hay fever, and, as a prophylactic, for low blood pressure in influenza and pneumonia. Quinine production has hitherto been virtually a monopoly of the Dutch, who control the supplies of bark and themselves manufacture by far the major portion of quinine produced, with the United States of America, Germany, France, and Japan comparatively small producers,



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and one maker in Great Britain. A second name is now mentioned in connection with quinine manufacture in this country. A British firm is understood to have taken up also the manufacture of cocaine.

A class of fine chemical manufacture which, although a younger industry than the production of synthetic remedies, has come prominently to the forefront and shown rapid development, is the manufacture of bio-chemical products. This new development, in which Great Britain occupies a leading position, is of increasing importance in relation to the treatment of diseases.

Hormones and Vitamins

As noteworthy achievements in this field of manufacture we were able to record in 1926 the manufacture of both the natural and synthetic thyroxin, as well as an increased production of insulin which is now an important British manufacture. The manufacture of other hormones is now being undertaken by our fine chemical makers, and still further achievements have resulted from British manufacturers taking advantage of each new scientific discovery as it is made.

The latest development in the manufacture of bio-chemical products relates to vitamins, a subject which has attracted so much attention of late. On the scientific side, great credit for discoveries in this field must be given to the British scientific workers who have done brilliant pioneer work on this subject; while on the industrial side, British fine chemical manufacturers have been quick to utilise the published results of scientific researches and to translate them to industrial production, thus rendering the fruits of such discoveries available to the medical profession and to the public. As an instance one may take the important case of the production of synthetic vitamin D, the anti-rachitic vitamin. The publication of the researches of two British scientific workers on the action of ultra-violet light on ergosterol, which was proved to result in the actual formation of vitamin D, has been followed by the large-scale manufacture of irradiated ergosterol, or radiostol, as it is called. Thus, synthetic vitamin D is now available commercially. This synthetic vitamin has been proved to possess 200,000 times the anti-rachitic activity of good cod liver oil. Vitamin A also is being produced on the large scale by British fine chemical manufacturers, who are utilising for this purpose an oil which is a new source of supply of this vitamin. Hitherto the natural source of vitamins A and D has been cod liver oil, of which the concentrate is now being manufactured on the large scale. The new availability of vitamin A and of synthetic vitamin D renders us independent of cod liver oil and its concentrate for a supply of these vitamins.

Research for therapeutic agents carried on for many years in this country has given to the world important new remedies for the treatment of various diseases. As an example of this work may be mentioned the research on chemo-therapeutic substances for the treatment of tropical diseases which is at the present time being conducted by British fine chemical manufacturers. This work is being encouraged by the action of the Interdepartmental Medical Research Committee (a committee set up jointly by the Medical Research Council and the Department of Scientific and Industrial Research), in promoting a scheme of co-operation between firms and universities undertaking chemotherapeutical research. This scheme, now to be conducted by the new "Chemo-Therapy Committee," promises to give manufacturers the facilities they have always required and hitherto lacked in this country.

The Position of the Safeguarding Act

The stimulus afforded to British fine chemical manufacturers by the renewal for a further period of ten years of the Safeguarding of Industries Act has received a set-back to some extent by the removal from the list of a considerable number of chemicals, which are now exempt from duty imposed under Section I of the Act. The list of chemicals thus removed during 1927 numbers about 40, of which the following may be instanced as being of some importance to the fine chemical industry: Acetone, amidopyrin, barbitone, hydroquinone, R lead acetate, lithium carbonate, phenacetin, phenazone, R potassium hydroxide, R potassium permanganate, quinine, ethyl carbonate, resorcin, salol, and urea. One, at least, of these chemicals is being made in this country. Among others,

which are of minor importance, are methyl sulphonal, papaverine, and piperazin.

Summary

The condition of the fine chemical industry during 1927 may be said to show a sound consolidation and steady progress, although, apart from advances made in the field of bio-chemical manufacture, there has been no very outstanding feature peculiar to the year under review. Business in all sections of the industry has been affected over the greater part of the year by intense competition, which, however, has been easier of late as a consequence of an increased demand for British products. As has already been stated, there are recent indications of a steady improvement in trade, and on the whole the outlook, though not brilliant, may be described as quite hopeful and promising.

The Society of Chemical Industry

A Successful Year

THE annual meeting of the Society was held in July in Edinburgh under the Presidency of Mr. Francis H. Carr, C.B.E., who delivered an address on "Industrial Chemistry and Progress in Medicine." Many important meetings were held, including a joint meeting with the Biochemical Society, a meeting of the Chemical Engineering Group and a Conference on Coal Cleaning held under the joint auspices of the Fuel Section of the Society, the Institution of Gas Engineers, and the Coke Oven Managers Association. Visits were paid to important works in the neighbourhood and a delightful whole-day excursion to the South of Scotland was greatly enjoyed by those who took part in it.

An interesting feature of the occasion was the presentation of the Society's medal to Lt.-Col. G. P. Pollitt, D.S.O., in recognition of his distinguished services to British chemical industry. Col. Pollitt subsequently delivered a lecture on the development of the Synthetic Nitrogen Industry in Great Britain.

The next annual meeting of the Society will be held in New York on September 3, 1928, on which occasion a distinguished member of the Society will be nominated for election as president for the year 1928-29. On the invitation of the American Institute of Chemical Engineers, members of the Society of Chemical Industry and of the Institution of Chemical Engineers will be taken for a trip through Eastern Canada and parts of the United States to New York, which they will reach in time for the meeting of the Society. Subsequently members who wish to do so will have an opportunity of attending the annual meeting of the American Chemical Society at Swampscott, which commences on September 10, returning thereafter to England from Boston. It is hoped that a detailed programme of the trip and meetings will be published early in 1928.

In the report of the Society's work during 1926 attention was drawn to the formation of the Fuel Section. This section since it was started has done excellent work in holding important conferences on various fuel subjects, and from the interest shown in these subjects by members of the Society engaged in diverse branches of chemical industry it has become apparent that the Section supplies a want experienced not only by those who are engaged in occupations dealing essentially with fuel, but by all members of the Society. It has, therefore, been decided that in future every member of the Society shall be considered a member of the Fuel Section and that no subscription will be charged in the case of those who wish to become members of it. The Committee of the Section will continue to co-operate with the committees of the Local Sections, and with other bodies specifically interested in fuel, for the purpose of arranging conferences and meetings, at which papers will be read and discussed.

The Society continues to co-operate with the other allied societies and with many public bodies and scientific associations, such as those mentioned in last year's report. Its local sections also, to a large extent, arrange their monthly meetings in co-operation with the Institute of Chemistry and other chemical societies.

During the past year a considerable influx of new members has been experienced, and it is hoped that in 1928 an even larger number will be added to the register.

The British Dyestuffs Industry in 1927

By L. J. Hooley

It is from the technical and the manufacturing point of view that Mr. Hooley, of the research staff of Scottish Dyes, Ltd., discusses the main events of the past year in the dyestuffs industry. Points of interest are the great volume of technical work, the high prestige of British chemistry, and the number of important new colours of British manufacture.

REMEMBERING the outstanding developments of 1926, the present year seems by comparison uneventful. Ever since the war either the industry as a whole or a substantial part of it has been handicapped and disturbed over some important question or occurrence. There have been the Sankey judgment, the Dyestuffs Act, changes in personnel, an unsuccessful attempt at agreement with the German cartel, capital reorganisation, and the coal strike; and this is the first year in which it has been unhampered by external control and free to devote attention to internal affairs.

The more settled conditions this year are partly a result of the increased feeling of security following the formation of Imperial Chemical Industries, but they have been of great advantage in providing opportunity for the developments, which this amalgamation foreshadowed, to become effective. Simultaneously the criticisms of the industry which were frequent a short time ago are now much more seldom.

A Great Volume of Technical Work

The volume of technical work accomplished during the year is greater than ever, even if no discoveries of outstanding importance have been made. The latter can hardly be expected; dyestuffs have now been synthesised for seventy years and their production involves thousands of individual substances, so that advances do not stand out with the same prominence as in the newer branches of nitrogen fixation and oil fuel synthesis. With a very important section of the industry merged in Imperial Chemical Industries, the dyestuff industry is, to this extent, less distinct than before, and its success is connected with the other departments of the combine.

The results of the year have shown unmistakably that the breadth of view which characterised the inception of Imperial Chemical Industries is also guiding its working. Its formation has brought to general notice a record of management in its constituent units, which was not fully realised previously, and what is of extreme importance, it is clear that this has not been mere good fortune, but a result of principles which are understood and which are evident in the present working of Imperial Chemical Industries. Further, the wide outlook shown in the proposals for future technical development are an augury of the practical justification of the amalgamation in the future.

The prestige of the chemical industry at the present moment stands high, and is not lessened by comparison with the condition of some of the country's other basic industries. It appears, in fact, to be offering a lead not only in research, but also in wider industrial questions.

It will be some time before the full benefits of consolidation can be felt by the various units of Imperial Chemical Industries. Concrete evidences of the progress made can be seen in the reorganisation of the British Dyestuffs Corporation establishments, with concentration at the Huddersfield and Blackley works. Hexagon House has been opened and the new headquarters buildings of Imperial Chemical Industries are nearing completion, while the necessary extensions have been made at the Scottish Dyes Grangemouth works for the manufacture of its own and the Corporation's anthraquinone colours.

For the seventeen months ending March 31, the British Dyestuffs Corporation declared a dividend of $2\frac{1}{2}$ per cent. on the ordinary capital, and with the debit of £360,602 extinguished by the capital reorganisation, a way was cleared for an unhandicapped start of the next financial year.

The Imperial Chemical Industries' shares have shown very substantial appreciation during the year, while those of the British Alizarine Co. are now approaching their par value.

The Makers and the Price Problem

During the year a very substantial indication of progress was seen in the reduction of the import "license factor" from two and a half to twice the pre-war value. This reduction has followed quickly on the earlier one from three to two and a half. In meeting the wishes of the Licensing Committee in this way the makers have again shown their readiness to help the users to the utmost. In the dyestuff industry it is particularly easy for price concessions to be given at the expense of future development, and also in about eight years, prices have been reduced to one tenth and even less, in a market in which there is practically no room for reducing costs by mass production. The post-war industries have been at considerable disadvantage compared with the German, as they have always had to work with a very fine margin allowing no opportunity for creating reserves. They have not had any advantage such as the windfall from the successful manufacture of alizarine in the eighteen 'seventies and 'eighties and of indigo later. It is necessary to be able to see several years ahead in research; five years is a conservative estimate of the period which elapses between the discovery of an important dyestuff and its sale in substantial quantities, and new dyestuffs are in fact coming into the market at the present time, the patents for which were taken out before the war. It will be seen, therefore, how important this aspect is.

In estimating the new achievements of the British industry it is necessary to remember that these tend to be measured against an ever improving standard. It is natural for comparison to be largely with the German and Swiss manufacturers, but in the branches where development is fastest the position is already very much in advance of the pre-war one. A comparison of the vat colours of 1914 with those of 1927, shows not only a very much larger range, but a great change in the importance of individual products. Such British advances as are necessary to keep up in this way are very easily lost sight of. The intensity of research in fast dyes is greater than at any time previously. Under the existing licensing circumstances new foreign products have the advantage of providing colours to which there are no immediate equivalents, and the manufacture of these equivalents monopolises a high proportion of research.

Imports during the year are not yet available, but probably will not be very greatly different from last year. A large fraction of these are new colours. It is sometimes claimed that a much smaller range of dyestuff would be adequate to both maker and user, but there is no chance of any reduction at present, the existing number being added to weekly. Although the imports form only about 15-20 per cent. of the total production, these represent a total capital sum, which from the point of view of the national industry would be better in the hands of the British manufacturer.

Important New Dyestuffs

During the year some very important dyes and dyestuffs have been brought out by British manufacturers, each individual firm having made substantial contributions, and all types of colour being represented.



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Among these may be mentioned the Icol colours of the British Dyestuffs Corporation, manufactured to overcome the difficulty of dyeing viscose evenly, Naphthalene Fast Black N and 4B, Thionine Blue GO, Durindone Blue 4BX, Duranol Blue R and Duranol Brilliant Blue G; L. B. Hollidays have added among others Monochrome Brilliant Orange GR and the Paradone Direct Blacks; The British Alizarine Co., Alizanthrene Yellow 6R and Scottish Dyes several new Caledon colours and Soledon Black B. In addition J. W. Leitch and Co., J. C. Oxley's Dyes and Chemicals, Brotherton

and Co., have added to their azo, pigment, and other series. There are many branches of organic chemistry, the exploitation of which are of the greatest importance for the future, and where research must develop from dyestuff research organisations. With the recent amalgamations scope is provided for these which would have been impossible previously.

It becomes clearer every year how important was the establishment of the dyestuff industry as a base for the technical developments of the future, in which chemistry is playing a leading rôle.

Recent Developments in Chemical Fertilisers

By A. B. Bruce, M.A.

(Editor of Publications to the Nitram Agricultural Research and Advisory Department.)

Yet another aspect of the synthetic fertiliser industry is presented by Mr. A. B. Bruce (of the Nitram research staff,) who recalls some of the combined forms now coming on the market, indicates the gap between a laboratory success and its conversion into a commercial proposition, and emphasises the need of research and of beginning, on new lines, a study of balances.

GREAT interest was aroused by the announcement, made early in the year, that Imperial Chemical Industries, in association with the British Sulphate of Ammonia Federation, had set up Nitram Ltd. as a subsidiary company to undertake, *inter alia*, research and propaganda work in connection with the use of chemical fertilisers, or "artificial manures" as the farmer has been accustomed to term them.

The establishment of a research agency is a new departure but it may be regarded as the proper corollary to the advisory work which had previously been begun by the British Sulphate of Ammonia Federation.

So far as sulphate of ammonia is concerned, the scientific as well as the practical application of this fertiliser has, of course, been the subject of scientific attention all over the globe for nearly a century, in fact, ever since the discoveries of Sir John Lawes, *circa* 1840, gave birth to the new era of intensive farming. Nevertheless, many scientific problems still remain unsolved, for example, whether this chemical does, in fact, invariably promote soil acidity.

Post-War Demand for Nitrogen

But if 1840 signalled the beginning of a new era in agriculture, the cessation of the Great War will be recognised as an incident with an equally epoch-making development of chemical science in relation to agriculture. For from 1912 onwards the world's increased need for combined nitrogen (equally clamant in war as in peace) have been met by nitrogenous fertilisers, of which the fundamental constituent is nitrogen fixed from the air by various processes.

Roughly, the world consumption of nitrogen in the form of fertilisers just before the war was 723,000 tons. It is now nearly double, or 1,300,000 tons, and practically the whole increase comes from what has come to be known as synthetic nitrogen. Further, the consumption is increasing at the rate of 100,000 tons annually, the significant fact being that Oriental countries (such as Japan), with their teeming agricultural populations, are now alive to the supreme value of combined nitrogen as a food producer, and are demanding ammonium salts in ever-increasing quantities.

The main synthetic product now being manufactured in prodigious quantities (approaching 700 tons daily) at the Billingham factory is sulphate of ammonia, a form of fertiliser which long experience has made familiar to agriculturists and which, as it happens, has many virtues special to itself. The ammonia is made by the well-known Haber process, the direct combination of nitrogen (from the air) and hydrogen (from coal). The sulphuric radicle comes from anhydrite, an extensive deposit of which, by an almost providential accident, was found to lie directly below the Billingham site.

But the possibilities ahead are almost limitless, and it will be one of the principal tasks of Nitram to explore their economic application. Starting with ammonia, the production of nitric acid by oxidation is (chemically) easy. Again, the

synthesis of urea fertiliser from ammonia and carbon dioxide can be accomplished.

In addition to nitrogen, the growing plant demands phosphorus and potassium; these elements the farmer has hitherto supplied by suitable individual compounds found in nature in various combinations.

Rocks containing calcium phosphates and mineral deposits; probably of animal origin, are being exploited in a number of countries. Natural deposits of potassium salts (sulphates, chlorides, etc.) in France and Germany are being drawn upon, and, in the background, the Dead Sea offers attractive possibilities of exploitation.

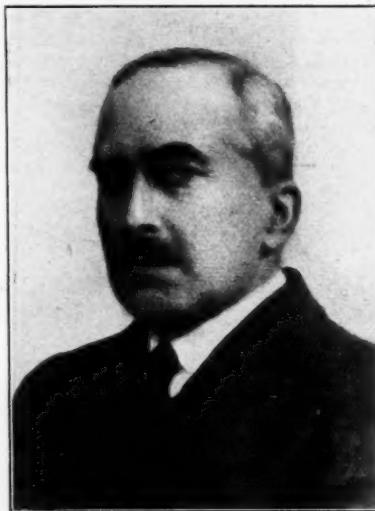
Already in Germany the great chemical syndicate known as I.G. is supplying agriculturists with fertilisers from which the inert materials have been extracted. Thus a synthetic ammonium phosphate is finding a market and, last of all, "nitrophoska" is a substance containing, in a readily available form, the trinity of essential plant foods, nitrogen, phosphorus, and potash, in varied proportions all water soluble and suitable to the needs of diverse soils and crops.

An attractive compound, and one which was being made "from the air" in Norway before the war, is calcium nitrate, a substance which has the virtues and none of the serious drawbacks, of the sodium salt.

At present this fertiliser is not being made at Billingham, but an equally effective substitute has been found in "Nitro-chalk," a mixture of calcium carbonate and ammonium nitrate. The outstanding value of this compound is that both nitric and ammoniacal nitrogen are present, each radicle playing a useful part at various stages of the growth of economic plants. At the same time, the presence of calcium carbonate ensures that the use of the fertiliser shall not draw in the often limited stocks of Ca in the soil.

Commercial and Chemical Aspects Contrasted

Before leaving the strictly chemical aspects of the subject, it may be of interest to point out that while the purely laboratory or theoretical combination of the radicles enumerated offers no particular difficulty, the translation of these processes into commercial and paying propositions offers serious problems. The commercialisation of a chemical process of various elements involves, first of all, the designing of a plant which shall ensure a continuous delivery at differentiated rates of the intermediate and end-products. This, in turn, necessitates the continuous regulation of the various tributaries to the main stream, and that regulation cannot be



MR. A. B. BRUCE.

rendered effective until full use has been made of the many forms of scientific measuring and recording instruments with which recent pure research in chemistry and physics have made us familiar. To this catalogue of factory problems may be added engineering difficulties, such as handling many yards and countless joints of piping carrying such pressure as 200 atmospheres.

Abundant reasons will now be apparent why, under modern conditions, scientific research is a necessary adjunct to a commercial propaganda in fertilisers and a further consideration may be added. For many years, essential plant foods have been studied from an individual point of view. Elaborate laboratory and field research has been conducted on the assumption that each element has an absolute value independent of the other. Of recent years, however, it has become abundantly clear that the relative balance of N.P.K. (at least) is of first importance. What in the past was regarded as potash starvation may well be the effect of want of nitrogen to balance defects in potassium, as well as in other elements such as phosphorus, or even calcium. The time is now ripe, therefore, for beginning, on new lines, a study of *balances*, and this study has many ramifications, such as the needs of

various soils, and diverse climates. The requirements of varied crops, are, in mathematical language, dependent variables and the possible combinations rapidly mount in powers of two. At the same time there are new questions of economic balance that require investigation, for the law of diminishing returns is applicable to the use of fertilisers, but with the post-war shift of values the critical point at which increased costs are not balanced by increased revenue has also moved.

These, and many other problems, it is hoped that the scientific members of the staff at the new research laboratories and farms of Nitram will attack. They will do so with the assurance that their efforts will meet with the sympathy of their director, Sir Frederick Keeble, F.R.S., who, at the outset, has laid down the salutary rule that the truth and nothing but the truth must be declared; for, in the past, the commercial outlook in scientific truth has perhaps been too economic. This wedding of scientific research and big business is largely due to the inspiration of Sir Alfred Mond, whose enlightened outlook on the new problems of the age has deservedly won him a commanding position in the industrial world.

Conditions in the Heavy Chemical Industry in 1927

By P. Parrish, A.I.C., M.I.Chem.E.

After reviewing the conditions in detail, Mr. Parrish, whose prediction of last year has been fully justified by the improved position of the heavy chemical industry, now considers it certain that the year 1928 may be approached with confidence and hope.

If 1926 was the age of big businesses, 1927 would appear to be the year signalling a definite forward policy. Industrial peace and an enlightened labour programme, co-ordinated chemical research, an appreciation of the importance of chemistry in relation to Empire trade, the recognition that the scientific utilisation of coal comes within the domain of the heavy chemical industry, and the extension of the works at Billingham, may be said to constitute the principal planks in the forward movement. No one will doubt its comprehensive character, or suggest that it lacks vision.

It is a truism that the future of our Empire is the future of Empire trade. It is interesting to note that our industries as a whole are beginning to translate it into timely action; not the least significant sign is that the heavy chemical industry of this country, led by the I.C.I., is preparing a united front throughout the Empire to competitors of other nations.

There is an unlimited field for the expansion of our Empire trade. In 1913 our Imperial trade was 25 per cent. (imports), and 36 per cent. (exports), of our total world trade. Clearly, an improvement is possible on these figures, and any step which seeks to develop the extension of such trade cannot but be sound.

Scientific Utilisation of Coal and the Heavy Chemical Industry

Few doubt that the scientific utilisation of our coal resources comes within the domain of the heavy chemical industry. The carbonisation of coal, whether by high or low-temperature methods is a chemical operation such as is encountered in the industry in question. But where the hydrogenation of coal is concerned, added support is lent to the foregoing classification. Failing the availability of hydrogen at a low price, hydrogenation processes(1) are economically impossible. The production of cheap hydrogen is an integral step in the manufacture of synthetic ammonia, which has always been included in the heavy chemical industry. Further, it is known that the Bergius process of hydrogenation involves the same class of technique as forms the basis of synthetic ammonia manufacture.

It is a significant sign of the times that the importance of the utilisation of our coal resources should be recognised in the way indicated. Much has been said and written during

the year about the production of oil fuel from coal. Whether low-temperature carbonisation and the Fischer process are likely to meet requirements remains to be seen. Dr. Bergius apparently places implicit trust in the process of the hydrogenation of coal(2) as a solution of the problem.

Important Extensions at Billingham

The announcement that two further units,(3) each with a capacity of 50,000 tons of nitrogen per year is a signal evidence of confidence. Each unit will produce 165 tons of ammonia per day, together with subsidiary plant to convert this ammonia into ammonium sulphate, ammonium nitrate, nitro-chalk, ammonium bicarbonate, and other products.

It is hoped to complete the programme by 1930, when the total output at Billingham will be equivalent to 2,100 tons of sulphate per day, or over 750,000 tons per year.

These preliminary observations are warranted when it is recalled that the operations of the I.C.I. largely affect the heavy chemical industry of Great Britain.

Synthetic Ammonia

Although much useful work has been undertaken during 1927, no technical development of outstanding importance can be reported. The manufacture of synthetic ammonia at the Oppau and Merseburg works is the subject of an interesting article(4). The layout of the plant is indicated, the lungs of the process—the great gasworks—are described, the preparation of the gases for reaction is outlined, and the sulphatising of the ammonia is treated in some detail. The Oppau and Merseburg works have an annual productive capacity of 100,000 tons and 400,000 tons of nitrogen respectively.

In the water-gas method of preparing gases for the ammonia synthesis, it is usual to remove carbon dioxide by scrubbing



Mr. P. PARRISH.

(1) THE CHEMICAL AGE, Vol. 16, pp. 132, 134, 159.

(2) THE CHEMICAL AGE, Vol. 16, p. 138. Vol. 17, p. 480.

(3) *Ibid.*, Vol. 17, p. 510.

(4) *Ibid.*, Vol. 16, p. 330.

the compressed gases with water. With a view to recovering carbon dioxide of a greater degree of purity H. J. Krase and H. C. Wetherington(5), scrub the gases with ammonia, to which ammonium nitrate has been added, to assist regeneration. The effect of ammonium nitrate is to increase the vapour pressure of CO_2 preferentially.

E. E. Arnold(6) burns blast furnace gases in air to convert the carbon monoxide and hydrogen to carbon dioxide and water, thus increasing the nitrogen content. The gas mixture is then compressed and purified by passing through ammoniated brine.

A good deal of work has been done on the subject of catalysts and apparatus, but reference to this matter will doubtless appear elsewhere in this issue.

A process by which ammonia is synthesised at atmospheric pressure is described by la Soc. d'Études Minières et Industrielles(7). The catalyst consists of iron, nickel, cobalt, or tungsten, or mixtures of these metals, together with 40 per cent. of lithium nitride, or amide. This is effective at 550/600° C.

Interest will doubtless be evinced in the low-pressure process of Carrara(8). Its chief features are: (1) estimated working pressure, 150 atmospheres; (2) greater simplicity with the individual parts of the apparatus; (3) longer life of the apparatus; (4) production of a 20/25 per cent. ammonia solution; (5) a higher yield and permanence of the catalyst; and (6) suitability for small production. An experimental plant has been erected to test the process. The results will be awaited with keen interest.

Lt.-Col. G. P. Pollitt(9) made a notable contribution on "The Development of the Synthetic Nitrogen Industry." As an antidote to pessimism, and as evidence of what this country can do under real scientific leadership and control, this article is probably unique.

One of the principal problems of the industry is the adaptation of its products to existing markets and the creation of fresh outlets for increasing supply. It is to this aspect rather than to process modifications that attention has been chiefly directed. In this connection the following table(10), showing the consumption of nitrogenous fertilisers in various countries, is based on information published by the Economic and Financial Section of the League of Nations:—

Lbs. per acre per year.	
EUROPE.	
Netherlands	38.2
Belgium	31.5
Germany	13.0
Denmark	8.7
Great Britain	7.1
Norway	4.8
Switzerland	4.6
France	4.3
Spain	2.8
Czechoslovakia	2.5
Sweden	2.3
Poland	1.2
Finland	0.9
Austria	0.8
Estonia	0.2
Hungary	0.1
ASIA.	
Japan	9.8
AFRICA.	
Egypt	8.1
South Africa	0.2
AMERICA.	
United States	1.8
Canada	0.3
Brazil	0.2
AUSTRALASIA.	
New Zealand	0.6
Australia	0.2

A recent development which may materially increase the consumption of nitrogenous fertilisers is the new system of intensive grassland culture. That there is room for development of sales is evident when the figures of the above table,

(5) *Ind. Eng. Chem.* 1927, Vol. 19, p. 208.

(6) U.S.P. 1,611,401.

(7) E.P. 253,540.

(8) *THE CHEMICAL AGE*, Vol. 17, p. 22.

(9) *Ibid.*, Vol. 17, p. 53.

(10) *The Times Trade and Engineering Supplement*, Nov. 26, 1927, p. 3.

relating to England, South Africa, Canada, Australia, and New Zealand, are contrasted with those of the Netherlands.

Brief reference to the untimely death of Dr. Luigi Casale must be made. He had won a high and honourable place among the chemists of the world, especially in the field of synthetic ammonia. His loss is deeply mourned.

Sulphuric Acid

While the world's production of sulphuric acid is apparently increasing, that of Great Britain is declining. Thus the period of extreme perplexity(11), to which reference was made last year, continues. The success of the sulphuric acid industry is indissolubly bound up with the calcium superphosphate and by-product ammonia industries, which absorb 70 to 75 per cent. of the total production of acid. The reason for many closed markets is known, but it is feared that the inevitability of modern tendencies must be accepted. It was hoped that a demand for strong acid would result from the development of the artificial silk industry (viscose process), but so far the effect is scarcely perceptible.

Fortunately, pyrolytic processes for the production of phosphoric acid are not without their difficulties. Electricity must be available at less than one-tenth of a penny per unit, if an electric furnace (simple crucible or shaft type) is to be pecuniarily successful. While an electric furnace is operating at Piesteritz, and is reported to be producing 70 tons of phosphorus daily, it is felt that economic considerations will militate against the adoption of the process in this country, at least, for some time yet.

Much can be said about technique, but space only allows of brief reference. The economic condition of the industry is reflected in the nature and extent of the technical progress made. Two features are outstanding: (1) the increasing attention that is being devoted to the liquid phase in the oxidation of sulphur dioxide by the chamber process, and (2) sources of sulphur dioxide hitherto regarded as uneconomic are being successfully explored.

The Gaillard turbo-disperser still commands attention, and has been largely adopted on the Continent and in the British colonies. Interesting details concerning the Mills-Packard plant and Schmiedel box have been furnished during the year. Other processes (those of C. W. Fielding, Y. le Monies de Sagazan, and H. Petersen) have been proposed in 1927. These, without exception, aim at intensive production and provide for intimate contact between SO_2 and nitrosyl-sulphuric acid, and for additional cooling to remove the heat of reaction.

Dr. Bailly's report(12), on alkali works, embodies the results of further work on the water scrubbing of Gay Lussac tower exits. The conclusions reached are: (1) that the efficiency of the water scrubber as regards absorption of SO_2 , and recovery of nitrogen oxides was highest when the total acidity of the entering gases was low, and (2) that efficient working depends on the maintenance of such a water feed as yields an effluent acid having a specific gravity not exceeding 8° Tw.

By-Product Ammonia

No chemical industry is faced with bigger problems than the by-product ammonia industry. Attention has been devoted to new methods for recovering ammonia, with a view to cheapening costs of production. No single process is likely to meet the necessities of the case. It is wrong in principle to have a large number of small works producing comparatively small quantities of sulphate. Central works should be established and their location should be judiciously selected, with due regard to transit charges and markets.

The utilisation of anhydrite in lieu of sulphuric acid is only possible on a fairly large scale, as the process needs efficient plant, skilled operatives, and careful chemical supervision. Where the size of the installation does not justify the foregoing, then it is desirable to continue the use of sulphuric acid.

Patent literature reveals that coke oven works are devoting attention to the utilisation of the cheaper radicle. The pronouncement of Prof. Connerade, of the Mons School of Mines, must not be lost to view. Speaking at the Belgian Gas Association Jubilee meeting this year, he said: "You must recover your own sulphur, and avoid sulphuric acid

(11) *THE CHEMICAL AGE*, Vol. 16, p. 10.

(12) *Ibid.*, Vol. 16, pp. 589, 592, 594; and Vol. 17, p. 75.

altogether, say, by transforming ammonia into urea, or by saturating it with phosphoric acid." This same idea has already received careful consideration in this country. The N.P.K. process of Mr. Pease bears witness to this.

Meanwhile, the prospects of the by-product ammonia industry are not rosy. Prices are likely to decline still further, until an equilibrium is reached. This may, and conceivably will, involve a limitation in the production of synthetic ammonia, but it should have the advantage of stabilising prices.

Effluent Problem

Considerable work has been done in this connection, but a simple and inexpensive process has not yet been evolved. It is feared that the removal of phenols from gas liquor by benzene, or from effluent liquor by means of benzene or activated carbon, is not likely to prove satisfactory.

Superphosphate Industry

Signs are not wanting that the superphosphate manufacturers of this country are equipping themselves in the hope of recovering lost markets. Although somewhat belated, the recognition that mass production is all-important is re-assuring. The International Superphosphate Association(13) has been organised to defend itself from the competition of rival fertilisers, in the hope of solving its problem of regional over-production by stimulating an improved demand for its products. An experimental station has been opened at Hamburg, as well as a bureau for the exchange of manufacturing information, etc.

When di-ammonium phosphate is assuming so much importance by reason of its manufacture by the Liljenroth process(14), it is interesting to observe that pure di-ammonium phosphate is not as simply produced from strong acid as the mono salt. In passing ammonia into concentrated phosphoric acid, the heat of reaction is such that the solution will no longer take up ammonia when a point is reached mid-way between the mono and di-ammonium phosphates. Apparently, if the solution is cooled at this point, the whole mass solidifies, which prevents the absorption of sufficient ammonia to convert the product completely to the di-salt.

The European rights of the Liljenroth process(15) have

been acquired by the Badische Anilin und Soda Fabrik, which has erected large plant on the Elbe, Germany.

Alkali Industry

The strength of the alkali industry is generally recognised. That the recent amalgamation has proved an advantage to the public is revealed by the reduction of prices for soda ash and caustic soda.

An interesting article, bearing on British export trade in caustic soda, shows that large shipments may be classified to include three well-defined groups of markets, each being of almost exactly similar proportions. Thus of the whole of our overseas trade in caustic soda, European countries take 22 per cent., slightly more than the combined countries of South America, which demand 21 per cent., and just less than the countries of the Far East, including Japan and China, which take another 23 per cent. of the whole.

Summary

The prediction of last year has been fulfilled. The heavy chemical industry has improved its position, despite the somewhat unsatisfactory state of the sulphuric acid and by-product ammonia sections.

The scientific utilisation of our coal resources may conceivably consolidate its position still further. If the formidable quantities of domestic fuel used to-day could be replaced with a gaseous medium or a solid smokeless product, an increasing demand for sulphuric acid would inevitably follow, as additional quantities of ammonia would be produced by either process.

The coal industry can only increase its sales by the displacement of imported oil. Pulverised fuel for ships and for other installations where oil is used at present is the direction in which its salvation is to be expected.

The latest chemical trade returns are distinctly encouraging. The industry is steadily recovering control of the principal sections of the chemical export trade—an indication that the sound policy, which is the subject of earlier reference in this review, is bearing fruit.

That 1928 can be approached with confidence and hope appears certain.

Chemical Inventions of the Year

By Our Patents Correspondent

The following carefully compiled review of chemical patents during the year indicates generally the trend of research and invention, and bears testimony to the great activity in invention that distinguishes the chemical industry. It will surprise many readers to learn that about 75 per cent. of British chemical patents are held abroad, mostly in Germany, Switzerland, and France.

THE activity of invention in a trade or industry, is a fairly good reflection of the industrial development and efficiency of the industry, and in these days of the universal application of scientific principles to industry, the patent specifications form the latest and most up-to-date record of present practice as well as an indication of the trend of development. Judged by these standards the chemical industry may be regarded as one of the most progressive of all, and there is no branch of it in which improvement has not been evident. Possibly the most remarkable development has been in the number of applications for patents by the I. G. Farbenindustrie Akt.-Ges., which this year is about double that of 1926, and now amounts to an average of about two every day. It is of interest to note that about three-quarters of British chemical patents are held abroad, mostly in Germany, Switzerland and France, while taking the field of invention over all industries, about 20 per cent. of British patents come from Germany, 6-8 per cent. from France, 2-4 per cent. from Switzerland, 20 per cent. from the United States—which provides relatively few chemical inventions—and 4-6 per cent. from the British Empire. A brief notice of a few of the inventions of the year follows, but the survey is, of course, in no way exhaustive or complete. The numbers in parentheses are those of the British specifications concerned.

Synthesis of Methyl Alcohol

Invention has again been very active in the synthesis of methyl and higher alcohols and other organic compounds from carbon monoxide, carbon dioxide, and hydrogen, and

the conditions and catalysts necessary for the production of such compounds have been further studied. Thus in regard to the synthesis of methanol itself a process has been devised (266,405) for the use of gases containing a large proportion of inert gases, which are available cheaply and in large quantity by distilling bituminous coal or by cracking. The hydrocarbons are partly oxidised by a restricted combustion to obtain carbon monoxide and hydrogen, sulphur compounds are removed, and during the synthesis part of the gas is continuously removed and replaced by fresh gas to maintain a constant composition. The excess of heat is absorbed, and a higher yield is obtained.

Apart from improvements in the plant, most of the inventions in this field relate to new catalysts which give advantageous conditions of working. Amongst others may be noted (262,494) zinc oxide, which renders an excess of hydrogen unnecessary and enables water gas to be used; mixtures of strontium and lead oxide, zinc and bismuth oxide (265,048); mixtures of oxides of zinc, magnesium, cadmium, chromium, vanadium or tungsten with oxides of copper, silver, iron, nickel, cobalt, and a halide of zinc, magnesium, chromium, or copper (271,840); for example, a mixture of zinc and chromium oxides and zinc chloride (272,864). Basic zinc chromate has also been used (275,345), and formates of metals giving irreducible oxides, supported on pumice, asbestos, or charcoal (274,492).

An interesting process for the production of keten and its subsequent use for the direct production of acetic acid or anhydride (262,364) is that in which a mixture of hydrogen

(13) THE CHEMICAL AGE, Vol. 16, p. 575.

(14) *Ibid.*, Vol. 17, p. 439.

(15) *Ibid.*, Vol. 17, p. 195.

and carbon monoxide is heated to 200°–300° C. at a pressure of 200 atmospheres in the presence of catalysts such as are employed for methanol synthesis, *e.g.*, zinc oxide, copper oxide, copper or zinc chromate, zinc aluminate, potassium zincate, etc. In a somewhat similar process (262,832) acetic acid is obtained from equimolecular proportions of hydrogen and carbon monoxide by employing catalysts which are, or are capable of forming, acetates which decompose with formation of acetic acid between 200° C. and 300° C., and at a pressure of 50–150 atmospheres. If such catalysts are capable of combining hydrogen and carbon monoxide they are used alone, but if not, they are associated with catalysts such as are used for methanol synthesis. The catalysts which are employed include copper oxide, tin oxide, lead oxide, copper acetate, aluminium methylate, and tin methylate. Another invention of this class (268,890) employs water gas containing 40 per cent. of carbon monoxide, which is treated under pressure with alcohols in presence of a metal alcoholate to obtain alkyl formates. The process is continued till the carbon monoxide content falls to 20 per cent., and the residual gases are then passed over another catalyst to obtain methanol. Suitable conditions attending the reaction between oxides of carbon and hydrogen may result in the production of hydrocarbons (271,452) if a catalyst of iron, nickel, cobalt, or molybdenum obtained by the decomposition of the vapour of their carbonyls is used, while if the proportion of carbon dioxide in a mixture of carbon monoxide and hydrogen is less than 3 per cent. the production of higher alcohols is favoured (275,284).

Synthesis of Ammonia

No very great departures from the generally known principles of established processes for the synthesis of ammonia have been noted, and most inventions are concerned with improvements in the efficiency of the plant, especially in relation to the heat economy in the Claude process, or with new catalysts. Several are based on pure iron obtained from iron carbonyl, and in one case (267,554) the iron is mixed with a small proportion of alumina, magnesia, or zirconia, and a trace of potassium nitrate, melted in oxygen, and the product reduced with hydrogen to obtain the catalyst. In connection with the preparation of pure iron, a new process of interest (269,677) is that in which iron carbonyl is passed into a heated vessel at some distance from its hot walls, and decomposed preferably at 250°–300° C., but not above 400° C., to prevent recombination. It may also be of interest to note that iron carbide forms an efficient catalyst when employed below 450° C. and that its efficiency improves after a period of use (271,482).

In the production of hydrogen for ammonia synthesis by decomposition of hydrocarbons (274,610), a purer gas is obtained if a pressure below atmospheric and a temperature above 1,000° C. is employed, together with an excess of steam, *e.g.*, a mixture of methane, oxygen and steam may be heated to 1,100°–1,300° C., and the products used for the synthesis of ammonia or alcohol.

Fertilisers

Inventions in chemical fertilisers have been numerous, both in the plant for manufacture and in the processes concerned. Thus, in one case (264,867) raw phosphate is treated with sulphuric acid, and the mixture of mono-calcium phosphate and calcium sulphate suspended in water and treated with ammonium carbonate. Di- or tri-calcium phosphate and calcium carbonate are precipitated and ammonium sulphate remains in solution and may be recovered. Several patents relate to the economical production of urea crystals, such as by spraying a 50–90 per cent. solution into a tower 20 metres high, against an ascending current of gas, to obtain a crystal pulp which when dried yields a mass of needle-shaped crystals (266,378). The difficulties associated with the caking of artificial fertilisers have also been further investigated. As an example of a non-caking mixed fertiliser may be mentioned a mixture of ammonium nitrate and precipitated di-calcium phosphate, which contains 40 per cent. phosphoric acid in available form. Potassium salts may also be added to make a complete fertiliser (269,235).

Another invention (262,017) obtains a homogeneous phosphate-sulphur fertiliser by heating waste material containing sulphur and condensing the vapour in a vessel containing powdered phosphate. A novel process for obtaining am-

monium sulphate (262,320) involves the treatment of distillation gases to remove ammonia, sulphuretted hydrogen, carbon dioxide, and hydrogen cyanide, followed by scrubbing with aqueous ammonia. The liquor is directly treated with calcium sulphate to obtain ammonium sulphate. A process has been patented (262,833) for treating natural phosphates containing substantial amounts of iron or aluminium to obtain a mixture of substantially neutral water-soluble phosphates of the type K_2HPO_4 , and neutral phosphates insoluble in water but soluble in citric acid or ammonium citrate of the type $CaKPO_4$. Fewer inventions relating to calcium nitrate have been noted.

Dyes and Dyeing

An unusually large number of patents relating to the manufacture of organic dyestuffs and to dyeing processes have been applied for or granted during the past year. The activity in this direction has not been confined to one class of dyestuffs, though the tendency is decidedly towards the production of fast dyestuffs for the ordinary textile fibres, and dyestuffs particularly applicable to special fibres such as viscose silk and cellulose ester silk. Amongst the azo dyes those derived from 1-phenyl-5-pyrazolone or acetoacetic arylides continue to attract much attention; they are usually yellow to orange acid or mordant dyestuffs for wool, those pyrazolones from amino-3-carboxy-4-oxydiphenylsulphide being particularly interesting, as the groups conferring mordant dyeing properties are remote from the chromophore group (272,024). Another interesting class of dyestuffs for viscose and other regenerated cellulose artificial silks is derived from 2-amino-8-naphthol-6-sulphonic acid or its ureas or thioureas or similar derivatives containing two molecules of the acid, united through the amino groups by $-CH_2CH_2-$, $-COCO-$, etc. Such dyestuffs should have less substantive properties than those derived from the corresponding 2-amino-5-naphthol-7-sulphonic acid, and in fact are stated to yield level shades on viscose silk, which, as is known, have such a great affinity for many substantive dyes that the dyestuffs are taken up too quickly and therefore unevenly (270,446, 270,883, and 277,756).

Amongst the azo dyestuffs suitable for production on the fibre (ice colours), those derived from 2:3-oxynaphthoic arylides and certain acetoacetic arylides (Naphthol AS and various marks thereof) continue to hold first place, a large number of new combinations yielding red to black shades being described, also modified methods of applying them (262,537, 262,987, 274,128, 275,147, 275,613, 279,146). The application of ice colours in conjunction with sulphur dyes to obtain mixed shades has also been described (266,387); also the use of oxynaphtho-carbazoles as coupling components for use in ice colour processes, red to brown and black shades being obtainable (275,326).

A considerable number of azo dyes suitable for application to cellulose ester silks have again been described; they are usually of acidic character but not strongly so, such character being conferred, for instance, by the presence of nitro groups and not more than one sulphonic group, carboxylic groups, sulphonamide groups, or sulphamic acid groups (265,767, 266,940, 267,695, 270,351, 270,352, 270,428, 275,230, 275,307, 275,373). Other dyestuffs which have been proposed for cellulose esters may conveniently be mentioned here, though in some cases the production of the dyestuffs themselves may not be claimed as new: azo dyes containing dioxyalkylamino groups (269,934 and 274,823), nitroacridines (275,752), oxyalkyl-amino-anthraquinones (275,636), and 1:4-diamino-2-alkoxyanthraquinones (272,482) and other aminoanthraquinone derivatives, esters of leuco vat dyes (274,094). Various modifications in the methods of obtaining suspensions of insoluble dyes for dyeing cellulose esters and the dyeing of such esters with the aid of mordants are also proposed (273,692 and 273,693).

Unabated interest in the vat dyestuffs continues, particularly in those of the anthracene series, both as regards new dyestuffs and the better production of old dyestuffs. A new synthesis of Jade green from Bz2-nitrobenzanthrone (made by nitrating benzanthrone under particular conditions) by exchanging the nitro group for methoxy, and fusing with caustic alkali, has been published (278,651). A general method for the production of dibenzanthrone and its substitution products consists in alkali fusion of 2:2'-dibenzanthronyls, which can be obtained by oxidising benzanthrone under

suitable conditions (262,819 and 263,861). Halogen dibenzanthrones are described in other inventions (263,826 and 262,774). A number of inventions relate to vat dyestuffs of the thioindigoid series (262,457, 266,382, 267,177, 271,906, and 274,527).

In connection with the soluble ester derivatives of leuco vat dyes now on the market under the name of "Soledon" colours (Scottish Dyes, Ltd.) and "Indigosols" (Durand and Huguenin), a number of modified methods for their manufacture have been described in addition to the new methods of applying them previously mentioned (263,898, 267,952, 271,533, 274,156, 277,398, and 278,399). The use of these interesting products will probably increase and they will prove a useful addition to the range of fast dyestuffs.

Treating Coal

A large number of patents have been taken out in this branch of the industry, and there is no doubt that this activity is likely to continue, in view of the industrial importance of the subject and its undeveloped state. Most of the inventions relating to the production of oil from coal are concerned with the working conditions and of the plant involved, and are hardly suitable for reference in a brief review of this kind. Amongst others may be noted one (277,419) in which coal is ground in oil, and heated to 400° to 500° C. at a pressure of 100 to 600 lb. per square inch, to obtain light hydrocarbons, another (277,293) in which coal is extracted with pyridine under pressure and then carbonised to obtain a voluminous carbonaceous residue, another (278,577) in which the latent heat of steam used for the steam distillation of coal is subsequently made use of for raising clean steam.

A novel departure is made in an invention (267,359) according to which benzol and other aromatic hydrocarbons are obtained by treating bituminous coal with hydrogen at a high temperature and pressure in a rapidly alternating magnetic field, while another inventor oxidises coal by treating it with an alkaline solution of alkali manganate or permanganate. Brown coal, lignite, or bituminous coal may be thus treated, yielding various products, chiefly mellitic acid (268,006). A process of interest in the destructive hydrogenation of coal, oil, tar, bitumen, etc., employs as catalysts elements of the third and fourth groups, and the products are heated with cobalt, molybdenum, or tungsten, yielding 90 per cent. benzene (273,712). Tars, mineral oils, etc., can also be converted into low boiling oils if treated with steam in the presence of activated hydrogenating catalysts at a temperature above that necessary for the formation of hydrogenated compounds, 268,774; while another process (277,394) for obtaining lower aromatic hydrocarbons from polynuclear hydrocarbons, phenols, tar fractions, etc., treats the vapour, mixed with a large proportion of water vapour, with catalysts having hydrating and dehydrating properties. In this way, benzene is obtained by treating polynuclear hydrocarbons with nickel, cobalt, iron or copper. One of the difficulties encountered in the destructive hydrogenation of carbonaceous materials is the deposit of carbon in the apparatus, and it has been discovered that this can be prevented (275,662-3-4 and 275,670) by lining the apparatus with alloy containing cobalt, molybdenum, tungsten, vanadium, manganese or nickel, and boron, arsenic, antimony, silicon, bismuth, phosphorus, or sulphur. The lining also has catalytic properties.

Treating Hydrocarbons

Processes somewhat analogous to those employed for treating coal, tars, etc., are also employed for treating gaseous and other hydrocarbons to obtain low boiling compounds, and also various oxidised compounds. Gaseous olefins can be polymerised by heating to 300°-500° C. in the presence of suitable catalysts (261,393), and the products then dehydrogenated at 550° C. under pressure in the presence of catalysts such as molybdenum, tungsten, copper, zinc oxide, active charcoal, or silica, to obtain compounds such as benzene. In this connection, some new dehydrogenation catalysts (262,120) may be noted, viz., sulphides of zinc, nickel, cobalt, iron, aluminium, cadmium, calcium, magnesium; these are, however, more particularly applicable to such reactions as the production of isobutylaldehyde from isobutyl alcohol. Methane is the starting-point in another invention (264,827) according to which the gas is passed under pressure and at 700°-1000° C.

over alkaline earth metal salts, or salts, oxides, hydroxides of magnesium or beryllium, or compounds of selenium, tellurium or thallium, or active silica or charcoal, the gases being removed quickly from the reaction zone. Acetylene is the main product at high temperatures, and ethylene at lower temperatures.

Methane can also be converted into hydrogen, carbon monoxide, and acetylene, and ethane into ethylene by heating to 900° C. and passing through a flame zone in a quartz tube at 1000° C. (265,234). Again, methane containing some hydrogen may be passed through an electric arc, and the acetylene formed absorbed by active charcoal, the residual gases being then heated to 1100° C. by preheating followed by partial combustion. The hot gases are then passed over a nickel-alumina catalyst to obtain a mixture of hydrogen and carbon oxides which can be used for the synthesis of methanol (269,547). According to another invention (273,832), olefin hydrocarbons are treated with ozonised air to obtain substitutes for turpentine, drying oils, and resins.

Some Organic Compounds

A good deal of attention is being paid to the synthesis of various organic compounds, particularly those containing oxygen, from their elements or from simpler compounds, in addition to the well known synthesis of methanol and other compounds already referred to. Thus the oxidation of hydrocarbons is illustrated by an invention (263,201) which employs as catalysts the oxides of metals of the fifth, sixth, or higher groups, such as those of vanadium, molybdenum, tungsten, chromium, uranium. A convenient method of applying this invention in the case of toluene is by spraying a colloidal solution of vanadium oxide in toluene into air, and heating it to 200°-300° C. The products include benzaldehyde and benzoic acid, which are condensed out. A similar treatment applied to benzene yields maleic anhydride, while naphthalene yields phthalic anhydride. In this connection it is of interest to note (272,557) that in the catalytic oxidation of organic compounds in a gaseous state the products are obtained in a purer condition if before separation they are brought into contact with pumice, silica gel, or active carbon.

Another oxidation process which in this case employs electrolysis (265,272) and is applicable to anthracene, toluene, *m*-xylene, naphthalene, etc., uses a special catalyst made from Swedish cerite ore by boiling with concentrated sulphuric acid, adding water, decanting, precipitating by caustic soda or oxalic acid. The red catalytic substance obtained contains a rare element similar to didymium. An interesting process for obtaining aliphatic and cyclic primary amines (265,960) is that in which hydrogen and ammonia react on the corresponding aldehyde or ketone or their ammonia compounds in the vapour phase, and in the presence of a hydrogenation catalyst such as nickel. A dehydration catalyst such as aluminium phosphate or alumina may also be present. Cyclohexanone may thus be converted into cyclohexylamine, *n*-butylaldehyde into *n*-butylamine, acetone into isopropylamine, etc.

The production of aldehydes from carboxylic acids is illustrated by a process (267,925) according to which the acid vapour is treated with carbon monoxide at 200° C. to 500° C. in the presence of a hydrogenation catalyst such as iron, or chromium and iron, and in another new process (272,155) formaldehyde is directly obtained from carbon monoxide and steam at a temperature of 340° C. and a pressure of 450 atmospheres in the presence of a metal of the magnesium or zinc group, manganese, tin, antimony, or magnesium antimonate. Acetaldehyde has also been obtained (260,305) by a reaction between acetylene and water in the presence of a mercury compound such as the sulphate, and a solvent for acetylene such as a mono- or poly-hydric alcohol, phenols, carboxylic acids, and ketones, acetal, or an ester. The vapour is fractionally condensed to obtain the acetaldehyde, the alcohol being returned. Several processes have been patented for the production of acetic anhydride from acetic acid, notably one in which acetic acid vapour is heated to 800° C. with aluminium phosphate as a catalyst, in a chamber of copper (272,923 and 272,951), and another (279,916) which makes use of the fact that acetic acid vapour which has been heated above dissociation point may be cooled to condense out acetic anhydride if the temperature is not lowered sufficiently to condense the water vapour.

Catalysts

The ever-increasing use of catalysts in chemical processes has been one of the most outstanding developments in recent years, and in addition to those already referred to, one or two others of general interest may be noted here. Thus a method of preventing loss and increasing the activity of catalysts which are volatile (262,475) consists of absorbing the vapour by active carbon, pumice, or silica, a mass of which is placed on either side of the catalyst while the stream of gases is occasionally reversed. This may be used to prevent loss of cuprous chloride in the Deacon chlorine process. Another method which should be of wide application (263,758) is one which will indicate the exhaustion of a catalyst. It consists in adding a substance which will disintegrate by absorption of a catalyst poison, and thus indicate the fact that the catalyst is spent by the presence of dust in the gases, or by an increased resistance to the flow of the gases. Thus a mixture of metal oxides with lime will disintegrate, due to the absorption of water by the lime.

Another invention (274,904) applicable to many gaseous reactions, such as hydrogenation, synthesis of methanol and ammonia, etc., employs the catalyst in a form so finely divided that it circulates and remains in suspension in the gases, and is removed after the reaction. Much has been done in the preparation of various catalysts in forms that show increased activity, e.g., in the production of trivalent chromium compounds for the synthesis of methanol, or production of hydrogen from carbon monoxide and steam, and for dehydrogenation

(272,555); also iron catalysts from iron carbonyl; nickel, tungsten; and other oxides.

General

In the rubber industry the interest shown a few years ago in synthetic rubber has almost disappeared, and attention is now principally directed to the direct use of rubber latex for manufacturing purposes, particularly for impregnating fabrics. Plant for curing and otherwise treating rubber is represented by a few inventions, as well as processes for regenerating and recovering waste rubber. Greatly increased activity has been evident in the study of compounds for accelerating vulcanisation and improving the strength and ageing of vulcanised rubber, a considerable number of these inventions originating in the United States. Among a wide variety of vulcanisation accelerators may be noted several condensation products of aldehydes with amines and substituted acroleins, products from salts of xanthic acids and sulphur chlorides, mercaptotri-aryl-thiazoles, salts of acetic, butyric, valeric, palmitic, etc., acids, ditolylguanidine thiosulphite, and sulphides of thio-phenols. The commoner chemical products of commerce are represented by fewer patents than usual, with the exception, perhaps, of sulphuric acid—these mainly from the Continent. Some applications of the principle of distilling and heating by means of molten metals have been noticed particularly by the use of submerged flame burners. The pigment and colour industry is represented mainly by inventions relating to titanium pigments, blanc-fixe, lithopone, and iron oxide, in addition, of course, to the large class of organic dyestuff products.

Activities of British Chemical Manufacturers

International and Domestic Problems

THE past year has brought with it many new interests and sufficiently diversified problems to keep the various activities of the Association of British Chemical Manufacturers adequately engaged. At the same time, everyone will admit that the progress made during the year in chemical industry, if not entirely successful in compensating for 1926, has been sufficiently successive to justify a hopeful attitude towards the future. The work of the Association, therefore, in supplementing the work of the individual manufacturer by combined deliberations and negotiations is particularly justified, and the following brief indication of some of the more important items of interest will be recognised as essentially Association matter.

The 1927 edition of the Official Directory of the Association was published in the early months of the year, and has obtained its customary good reception at home and abroad. The modification in lay-out and the entire revision of the copy has been amply justified, and an authoritative and up-to-date directory of British manufacturers has thereby been made available.

International Conversations

The Association and chemical industry at large has been favoured during the whole of the international negotiations that have occupied such an important position in the history of the year by adequate and able representation. These, including the meetings of representatives of the Federation of British Industries and corresponding bodies on the Continent, as well as the League of Nations Economic Conference, have already borne valuable fruit, while at the same time it must be recognised that they probably represent only the preliminary stages in the direction of more harmonious international trade relationships.

In connection with the Economic Conference, the preliminary work of the Association in preparing a memorandum on chemical industry as a complement and supplement to that prepared in Germany was amply justified by the reception given to it at and after the Conference.

Recent Legislation

In the matter of legislation, the Association has taken an active part in connection with the Factories (No. 2) Bill, the Rating and Valuation Act of 1925, the Merchandise Marks Act of 1926, and, of course, the Safeguarding of Industries Act.

The history of the Factories (No. 2) Bill is well known, and it is sufficient to say that an active campaign on behalf of the members of the Association was carried on during the early

part of the year, while at present, with the reintroduction of the Bill before Parliament, the chemical manufacturers' interests are being carefully watched.

It was recognised that the practical significance of the Rating and Valuation Act of 1925 rested in the report which was to be prepared on the scope of the Act with respect to rateable machinery. This report, when issued, proved unsatisfactory in many respects, and as a result the order issued in May last in connection with the Act embodies a number of important points which the Association through its Council had raised for clarification.

The Merchandise Marks Act of last year proved to be a knotty problem for all the interested parties, and gave rise to a considerable amount of discussion and speculation. So far as chemical manufacturers are concerned, however, the application of the Act has been carried through with much less disturbance than was at first anticipated.

The activities in connection with the Safeguarding of Industries Act have this year centred round the investigations with regard to applications for exemption from duty for a period which have been received by the Board of Trade. In a large number of cases the applicants have been referred to British manufacturers, and in the remainder temporary exemption from duty has been granted pending the manufacture of the chemicals in this country.

Inter-Sectional Work

The appropriate sections of the Association have also taken part in work on the following matters:—Medical co-operation in research work, whereby the Association is negotiating with the joint committee of the Medical Research Council and the Department of Scientific and Industrial Research, to deal with greater facilities for the testing of new chemical products; the Public Health (Preservatives, etc., in Food) Regulations, in connection with which the Association acts with the Society of Public Analysts on the matter of the metallic impurity content in food; the proposed French Customs tariff; statistical schemes for the collection of production data relating to chemical industry, and so on.

Finally, the Traffic Committee, by its usual activities, and by the help given to members faced with difficulties which will arise on the application of the new classification on January 1 next, has contributed largely to the value attached to the work of the Association during the past year.

Tar Distillers

The Association of Tar Distillers has worked in conjunction with Group V. of the Association of British Chemical Manufacturers in all matters covering their common interests, such as the participation in the formation of the British Road Tar Association, research on the constitution of pitch, as carried out by the Department of Scientific and Industrial Research, in the collection of statistics of production, in attempts at the stabilisation of pitch prices, and, until the Standardisation of Tar Products Tests Committee was formed, on the questions of standard methods of test. The Joint Committee and the Standardisation Committee have kept in close touch with each other during the year.

The British Engineering Standards Association has kept the Association informed of proposed and effected alterations in Standard Specifications, and members have been able to express their opinion effectively on the questions raised.

The Public Health (Smoke Abatement) Regulations recently issued came up for consideration in draft, and satisfactory agreement with the ultimate proposals was obtained.

A number of interesting additions to the membership of the Association have been made during the year, and during the earlier months a useful Directory of the Association was published, copies of which are still available on application to the secretary.

Chemical Plant Manufacturers

The information bureau of the British Chemical Plant Manufacturers' Association has been as active as ever during the year, and members have expressed appreciation of this branch of the activities of the Association. The development of this section of the work depends on the publicity which it receives, and the aim of the Committee during the past year has been to extend the service by this means as much as possible. It is particularly gratifying to find that overseas inquiries form a substantial portion of the total, and in this connection the Department of Overseas Trade has worked in close conjunction with the officers of the Association in various cases.

It is, however, to the home manufacturer that the maker of chemical plant must first turn his attention, and here the task of converting the market to the more extended use of British-made plant is more difficult. The old idea that efficient chemical plant was only obtainable abroad has become obsolete, and this statement is being daily proved by experience. In addition the inquirer for plant is slowly but surely being converted to that opinion.

The Committee of the Association has had before it the consideration of the present conditions in the teaching of chemical engineering in Polytechnic Institutions, and is being kept in touch with developments in this direction.

Standard specifications issued by the British Engineering Standards Association have been distributed in draft form, and members have thus been kept informed of developments in which they were interested.

A consensus of opinion on the question of exhibitions resulted in a decision to hold a chemical plant exhibition every alternate year, if possible at the same time as a congress of chemists. As there will be no such congress in London during 1928, it has been arranged that a part of the chemical hall ("K") at the London Section of the British Industries Fair shall be devoted to a Chemical Plant Exhibition; as a result, plant manufacturers will have the unique opportunity of displaying their products in the same hall as the British chemical manufacturers themselves. It is considered that by this arrangement the two industries will have their mutual interests admirably served.

In conjunction with the Association of British Chemical Manufacturers, a Chrome Alloys Sub-Committee has reported on practical tests with chrome alloys with a view to ascertaining the scope of application of the stainless alloys.

The final result has been a general extension of the terms of reference of the sub-committee, who will henceforth arrange organised research on the scope of application of resistant metals and alloys to some typical chemical manufacturing problems.

Chemical and Allied Societies

Notes on Their Work During 1927

Institution of Petroleum Technologists

At the Second (Triennial) Empire Mining and Metallurgical Congress held in Canada in August and September, 1927, the Institution of Petroleum Technologists was represented by Sir Thomas A. Holland and Professor A. W. Nash; at the Seventh Congrès de Chimie Industrielle held in Paris in October, it was represented by Dr. A. E. Dunstan; and at the Berthelot centenary celebrations at Paris in October, by Mr. A. C. Adams, the president. The Institution's scholarship at the Royal School of Mines has been awarded to Mr. C. B. Roach, and that at the University of Birmingham to Mr. R. G. Ffoulkes-Jones. The Institution is represented on the American Society for Testing Materials; the Advisory Board of the Department of Oil Engineering and Refining of the University of Birmingham; the British Association for the Advancement of Science; the British Engineering Standards Association; the Fuel Economy Committee; and the Imperial Mineral Resources Bureau. It has branches in Roumania and Persia. The headquarters of the Institution are at Aldine House, Bedford Street, Strand, London, W.C.2.

International Superphosphate Manufacturers' Association

The International Superphosphate Manufacturers' Association was brought into being by a resolution of the delegates from 14 countries at a meeting held in London in December, 1926. Its objects are, in the main, to increase the consumption of superphosphate in all countries members of the Association, and with this end in view, to exchange information as between the member countries, to carry on experimental work, and by every means possible to demonstrate to farmers the great value of superphosphate as a fertiliser. The Association has now attracted to its membership 19 countries, of which 17 are European, with which are associated North Africa and South Africa.

The offices of the Association are at Aldwych House, Aldwych, London, W.C.2. In January, 1927, a propaganda office was established at Hamburg, Hammer Landstrasse 231, and in order to extend and develop the work of the Association, an experimental station was established, also in Hamburg, in March. Already very much valuable experimental work has been done, and as the structure for indoor experiments has been equipped with central heating, it will be possible to carry on the work right round the year. The phosphate and pyrites companies have shown a very active interest in the work of the Association, which is to be extended and developed to the fullest extent that the Association's resources will allow. The chief officers are: president, E. G. Martens; vice-presidents, R. Berr (France), N. P. Mathiasson (Sweden), and H. C. Scheibler (Germany); hon. secretary, A. N. Gray; propaganda director, H. Eggers (Germany). The experimental station is in charge of Dr. C. Krügel, and the actual experimental work is under the direction of Dr. Dreyspring.

Society of Dyers and Colourists

During the year, meetings and lectures under the various Sections have been held in Bradford, Manchester, Huddersfield, London, Leicester, Nottingham and Glasgow, reports of which appear in the monthly *Journal* of the Society.

The Dyers' Company's Research Medal, the gold medal given by the Worshipful Company of Dyers, one of the old London Guilds, annually to the author of the best original paper published in the Society's *Journal* during the previous twelve months, was awarded to Dr. H. H. Hodgson, M.A., of the Huddersfield Technical College.

The "Colour Index" of the Society, which was first published in January, 1924, has proved a great success, and the Society is at present engaged on the preparation of a "Supplement" to the Colour Index, which it is hoped will be ready for publication very shortly.

Under the chairmanship of Mr. F. Scholefield, a representative committee was appointed during the past year to consider "Standardising the Methods of Testing the Fastness of Dyed and Coloured Fabrics."

The secretary of the Society is Mr. J. B. Atkinson, 30, Pearl Assurance Buildings, Bradford.

Society of Public Analysts

The 52nd year of the Society has been an exceptionally prosperous one. Not only has there been a large access of new members, but there has also been a steady increase in the number of outside subscribers to its journal, *The Analyst*, in all parts of the world. These facts may be taken as objective proof that the Society is continuing to supply the need for which it was formed, namely, to advance the knowledge of all branches of analytical chemistry, and, in particular, to study and devise new methods of dealing with adulteration in all its forms. These aims are mainly carried out by means of papers read and discussed at the meetings and subsequently published in *The Analyst*. During the year 46 papers have been published, and several of these are contributions of permanent value to analytical chemistry. In addition, the Society from time to time invites distinguished specialists to give an account of recent advances in allied subjects, and these are also published in the journal. For example, an outline of recent advances in the methods of bacteriological examination of food and water by Dr. W. Savage was published in the January issue of *The Analyst*, and papers by Sir William Willcox, Dr. G. Roche Lynch, and Dr. Martley on the serological tests for blood and their use in forensic work are in the press. The Society now numbers 568 members. The officers are as follow: president, E. Richards Bolton, F.I.C.; hon. treasurer, E. Hinks, B.Sc., F.I.C.; hon. secretary, F. W. F. Arnaud, F.I.C.; secretary, and editor of *The Analyst*, C. Ainsworth Mitchell, M.A., F.I.C. The address of the Society is 137, Victoria Street, London, S.W.1.

The Ceramic Society

The Ceramic Society was originally founded at Stoke-on-Trent in 1900. In 1916 a special section was formed to deal with refractory materials, leaving the parent section at Stoke free to devote its attention mainly to the problems of the pottery industry. During the current year, a proposal has been put forward to establish a third section, namely, a Brick, Tile and Heavy Clay Ware Section. An inaugural meeting will probably be called early in the new year to settle the necessary details of organisation. There is little doubt that the new section will add greatly to the usefulness of the Society's activities.

Since the war, it has been the custom to arrange foreign tours each alternate year. Visits have been made to France, Sweden and Denmark, and Italy, and in the spring of this year the Society chose as its objective the clay-working areas of Czechoslovakia and Austria. An excellent opportunity was thus afforded of viewing the important kaolin deposits of Bohemia, and of seeing the electrical method of purifying clay in operation at the works of the Electro-Osmose Co. at Chodau. A joint meeting of the Czechoslovakian and of the English Ceramic Societies was held, at which a number of papers were read and discussed. The excursion programme also included interesting visits to factories, clay mines, and technical institutions.

In one respect the year 1927 has been a particularly memorable one in the history of the Ceramic Society. The hon. secretary to the Society, Dr. J. W. Mellor, has received the honour of election to fellowship of the Royal Society, and on October 20 last a complimentary dinner was arranged by the Society to celebrate the event. The following papers have been read at the monthly meetings held at Stoke during the year: Professor R. V. Wheeler, D.Sc., "Chemistry of Coal"; J. Konarzewski and A. E. J. Vickers, M.Sc., "Discoloration of Clays during Firing"; Dr. G. Martin, "Researches on the Theory of Fine Grinding"; W. Emery, "Refractories for the Pottery Industry—II"; R. C. Callister, "Blending of Clays"; J. Burton, "Continuous Biscuit Firing"; B. J. Moore and A. J. Campbell, "Electric Pottery Firing"; Dr. G. Martin, "Utilisation of Waste Heat for Steam Raising"; Professor W. A. Bone, "Combustion of Carbonic Oxide."

The autumn meeting of the Refractory Materials Section

was held at Bournemouth in conjunction with the Clay Convention. The subjects discussed at this meeting were:—R. S. Troop, B.Sc., and F. Wheeler, "Some Experiments in Drying Clay"; A. J. Dale, B.Sc., "Effects of Temperature on the Mechanical Properties of Silica Products"; W. C. Hancock, B.A., and J. G. Cowan, "Crushing Strength of Unfired Fireclay Bodies"; A. T. Green, F.Inst.P., "A Consideration of Open-Hearth Steel Works Refractories"; A. F. Joseph, D.Sc., "Characterisation of Clay"; W. Hugill, M.Met., and W. J. Rees, B.Sc., "Note on Silica Bricks made without Added Bonds." The headquarters of the Society are at the North Staffordshire Technical College, Stoke-on-Trent.

The Chemical Society

Of the fact that the Society has continued during 1927 steadily to pursue the work for which it was founded, namely, "the discussion and publication of new discoveries, and the interchange of valuable information respecting them," ample evidence is forthcoming, for it has held no less than 15 ordinary scientific meetings, at which 51 papers were discussed, and has published up to the end of November 386 papers, which, with notes and obituary notices, occupy some 2,900 pages in the *Journal*. Volume XXIII of the *Annual Reports on the Progress of Chemistry* has been issued, and the Abstracts "A" (Pure Chemistry) have been published in *British Chemical Abstracts*. In addition to the ordinary scientific meetings, the Society has held three special lectures. The first of these, the Kamerlingh Onnes Memorial Lecture, was given by Professor Ernst Cohen on February 10. The second, the Faraday Lecture, was given at the Royal Institution on May 18 by Professor Richard Willstätter, who chose as his subject "Problems and Methods in Enzyme Research"; and the third lecture, entitled "Gaseous Combustion at High Pressures," was delivered by Professor W. A. Bone in the meeting room of the Society on November 24.

The work of the council in awarding grants from the Research Fund Account for research work is rendered difficult by the sum applied for so far exceeding the amount available for distribution. During the year, 99 candidates applied for £1,056 5s., but it was only possible to award grants amounting to £697 10s. The library continues to be used more and more by Fellows of the Society and by the members of those co-operating societies which contribute to its upkeep. The attendances during the year were 7,692 as against 6,994 in 1925. The library now has 35,000 volumes. The present officers of the Society are: president, H. B. Baker, C.B.E., D.Sc., F.R.S.; treasurer, J. F. Thorpe, C.B.E., D.Sc., F.R.S.; secretaries, T. Slater Price, O.B.E., D.Sc., F.R.S., and C. S. Gibson, O.B.E., M.A.; foreign secretary, F. G. Donnan, C.B.E., F.R.S.; assistant secretary, S. E. Carr, F.C.I.S.; librarian, F. W. Clifford; while Dr. Clarence Smith is the editor, Dr. A. D. Mitchell the assistant editor, and Miss Le Pla the indexer. The Society's rooms are at Burlington House Piccadilly, London, W.1.

The Colour Users' Association

During the past year the Colour Users' Association has again been active in dealing with many matters of considerable importance to colour users. The council has devoted much attention to the question of dyestuffs prices. As a result of negotiations undertaken by the Users' representatives on the Dyestuffs Advisory Licensing Committee, the factor employed in determining applications for licences on price grounds has been reduced from 2½ times to twice pre-war. The question of the prices of chemicals used in the manufacture of dyestuffs has also been considered, and the Users' representatives on the Dyestuffs Industry Development Committee are keeping this question to the fore with a view to enabling the dyemakers to reduce their prices for colours. The Council has also followed the situation with regard to suggested international amalgamations in the dyestuffs world with keen interest, and will lose no opportunity of presenting the users' point of view in this matter.

Among other matters with which the Association has been concerned is the extension of the Safeguarding of Industries Act for a further 10 years, when the Association put forward a request for the exemption of oxalic acid from duty under this Act, and in due course the Board of Trade announced the

removal of this chemical from the dutiable list for a period of twelve months from March, 1927. The Association's vigilance committee is keeping a watchful eye on colour users' interests in connection with this Act. A considerable amount of work of importance to users has been dealt with by the standing committees of the Association—particularly by the publicity and statistics committee, who have given much time to the obtaining and consideration of statistics with regard to the prices, export, and import of dyestuffs, etc. The joint technical committee of dyemakers and dye users has also been very active during the past twelve months, chiefly with the revision and redrafting of the non-contentious list of colours which are not manufactured in this country. The revised list will be of great assistance to the Dyestuffs Advisory Licensing Committee. The Colour Users' Association indigo buying group has again co-operated with other organisations in the purchase of indigo under a system of rebates, and continues to function satisfactorily.

Newcomers to the Council during the past year are Mr. J. Nochar (Wallpaper Manufacturers, Ltd.) and Mr. E. C. Deakin (Bleachers' Association, Ltd.), while the Association has to deplore the death of Mr. A. Barran (Wallpaper Manufacturers, Ltd.), for many years a member of the Council until compelled to withdraw through ill-health.

The Faraday Society

The Faraday Society has made excellent progress during the year. The president for the year was Professor C. H. Desch, F.R.S. The number of papers published was 66, which is about half as many again as during 1926. General Discussions of very great interest and importance were held in the spring at Oxford on "The Theory of Strong Electrolytes," and in the late autumn in London on "Cohesion and Related Problems." Both attracted much attention on the Continent and in America; at the Oxford meeting there were some dozen foreign guests of the Society, of whom two came expressly from America and the remainder from all parts of the Continent. In addition to these General Discussions there was an extended Discussion on Dr. Vernon's Second Report on Atmospheric Corrosion, which was read before the Society in January.

The publications of the Society have appeared regularly every other month during the year, with extra numbers for the reports of General Discussions. The Transactions have acquired a reputation for the speedy publication of papers of excellent quality, but the supply of material was beginning to exceed publishing possibilities. In order to meet this situation the Council has decided, therefore, that future volumes of the Transactions shall be published in 12 monthly parts of about 48 pages each. The first part will appear on January 1, 1928, to be followed by the others normally on the first of each month. In the case of those General Discussions the report of which extends over more than one part, two (or more) parts may for convenience be published simultaneously within one cover.

The subscription to membership of the Society (including the receipt of the Transactions) will remain as before. The subscription rate for the Transactions in the case of non-members will continue to be £2 10s. per annum (postage extra), and single parts will be obtainable for 5s. each.

During the year, the offices of the Society, being no longer connected with the Institute of Physics, were removed to a convenient address in an academic atmosphere at 13, South Square, Gray's Inn, which is within two minutes' walk of Chancery Lane station.

The Institute of Chemistry

Apart from the Jubilee Celebration, one of the outstanding features of the progress of the Institute during the year has been the increased interest shown by the Fellows and Associates in the activities of their respective local sections. This has no doubt been, in the main, due to the character of the papers and addresses which have been given both at meetings restricted to members and at meetings held jointly with the local sections of other bodies. The scientific and technical papers have usually been reported in the chemical Press, while those relating to matters of general professional interest have been reported in the JOURNAL and PROCEEDINGS of the Institute, or have been published as separate monographs.

The scope covered is indicated by the following selection:—

At Belfast, Mr. J. C. A. Brierley dealt with "Chemistry as a Factor in Education"; Dr. J. Small, with "Hydrogen Ion Concentration in Plants"; and Dr. W. H. Gibson, with "The Profession of Chemistry." At Birmingham, Mr. F. H. Alcock dealt with "The Making of a Pharmacopoeia." At Bristol, Mr. T. Wallace lectured on "Researches on the Nutrition of Fruit Trees." Professor E. Newbery, at the Cape, lectured on "Appliances used in the Investigation of Colloids," and Dr. Ellwood Hendrick, on "Reminiscences of Some Chemists Whom I Have Met"; Mr. J. Adam Watson, at Edinburgh, on "Some Chemical Aspects of Geology" and on "Chemistry, the Slave of the Lamp," Mr. Francis H. Carr, on "Vitamins in their Relation to Industry," Mr. B. D. W. Luff, on "The Use of the Microscope in Qualitative Analysis," Mr. A. M. Cameron, on "Fire Risks in Industry" (published separately), Professor R. M. Caven, on "Chemical Formulae of Long Ago," and Professor Sir James Walker, on "Electro-Synthesis"; Mr. R. L. Collett, at Glasgow, on "The Chemist as the Professional Man" (also given at Bristol), Dr. C. S. Garrett and Mr. G. W. Riley, on "Beet Sugar Manufacture," Dr. D. F. Twiss, on "Sulphur in Rubber Manufacture," Mr. C. Chapman, on "Naphthas and Their Uses," and Mr. F. W. Harris, on "Municipal Chemistry"; Captain A. Foster, at Huddersfield, on "Forensic Chemistry or Chemical Jurisprudence," Professor R. Robinson, on "Electronic Displacement Theories in Organic Chemistry," Professor I. M. Heilbron, on "The Unsanctionable Matter of Oils and Their Connection With Certain Oil-Soluble Vitamins," Professor C. K. Ingold, on "Transmission of Reactivity in Molecules," Professor C. H. Desch, on "The Structure of Metals," and Mr. A. Cousen, on "Modern Glass Manufacture." Dr. T. J. Nolan, in Dublin (Irish Free State Section), lectured on "The Design and Functioning of Sporting Ammunition." This Section has also held an interesting exhibition of apparatus for special purposes, demonstrated by various members.

At Leeds, Professor J. W. Cobb lectured on "The Training of a Fuel Chemist," Mr. B. G. McLellan on "The Chemist in the Food Industry," Mr. H. Salt on "The Training of a Leather Chemist," and Dr. O. C. de C. Ellis, on "Flame." Dr. F. J. Brislee, in Liverpool, lectured on "Some Little-Known Properties of Aluminium and Lead." Professor J. C. Drummond on "Biochemical Aspects of the Nature of Life," Mr. A. J. Hall on "Cellulose in the Hands of the Chemist," and Mr. William French on "Reminiscences of Fifty Years of Chemistry"; Mr. George Stubbs, in London, on "Some Recent Legislation Affecting Chemists," and Mr. S. M. Gluckstein on "Chemists and Dividends" (published separately).

Before the Malaya Section Dr. J. L. Rosedale lectured on "The Role of Vitamin B in Nutrition," Mr. A. G. Harrington on "The Working of a Municipal Sewage Plant," Mr. J. C. Cowap on "Opium Analysis," Mr. F. L. Okell on "Tin and Its Analysis," Mr. J. Edwardes, on "The Preparation of Plantation Rubber," and Mr. R. O. Bishop on "Malayan Fibres." At Manchester, Professor J. B. Cohen lectured on "Air Pollution," Professor E. C. C. Baly on "Plant Chemistry," and Mr. L. G. Radcliffe on "The Institute and the Profession." At Swansea, Mr. E. Le Q. Herbert dealt with "Lubricating Oils: Their Preparations, Properties and Examination," Mr. J. R. Green with "Quantitative Spectrographic Analysis in Metallurgy," and Mr. E. A. Tyler with "Notes on Pure Chemicals."

In several instances, also, the Sections have held discussions on registration and other subjects, and have arranged visits to works and experimental stations, which, apart from their special interest, are found to be a most useful means—as have been the local Jubilee Celebrations—of affording opportunities for friendly intercourse. A new section has been established in New Zealand.

In March, Mr. A. Chaston Chapman gave a lecture at the Institute on "The Growth of the Profession of Chemistry during the Past Half Century," and, in November, Mr. O. F. Block delivered the tenth Streatfeild Memorial Lecture, taking as his subject "The Chemist in the Photographic Industry." These also have been published separately. Further, the Institute has published, during the year, the sixth edition of "A List of Official Chemical Appointments" and the second (revised) edition of "The Profession of Chemistry," the latter being prepared as a guide for aspirants to the profession.

Owing to a general falling off in the numbers of chemical students during the past few years, the increase in the roll of membership is likely to be less than the average annual increase since the war. Lack of suitable employment has contributed to the number who have taken to other work, but the increase in membership will still be substantial—over 200 net—and the total will probably exceed 5,400 when the annual report is published, early in 1928. The standard of the conditions of membership and of the examinations, however, has been fully maintained. In spite of the steady advance in membership, chemists are being absorbed in industry and other branches of work, and the record of unemployment remains fairly stationary. It is still rather difficult to place newly qualified chemists, and even those of maturer years, who have had good experience, sometimes find a difficulty in securing posts suitable to their attainments. It is clearly necessary, therefore, to impress upon newcomers that fortunes are not easily made by science and that a considerable measure of mental attainment, ability, and patience are essential for even moderate success. A report on salary statistics will be available early in the new year. The Benevolent Fund has received rather better support during the past year, but the Committee hopes to make a record subscription in 1928. The Meldola Medal for 1926 was awarded to Dr. R. G. W. Norrish. Other activities of the Institute—such as the work of the Public Appointments Committee in the interests of official chemists, the consideration of the question of registration and incidentally the title of the chemist, national certificates in chemistry, and other matters affecting the profession—are still before the council, and will be the subject of report in due course. The Jubilee Celebration is of such recent date that it would call for no further comment, but that the Council is very highly appreciative of the expressions of goodwill and kindness shown on all sides towards the Institute on this occasion, as well as of the support given to the functions not only by the Fellows and Associates but also by the members of all participating societies and institutions.

The Institute of Fuel

The Institute of Fuel has resulted from the amalgamation of the Institution of Fuel Technology and the Institution of Fuel Economy Engineers, which was effected during 1927, with a view to the constitution of one central authoritative organisation, which would co-ordinate work relative to fuel and help to make the experience of every industry available to all. The great national importance of such an Institute is emphasised by the rapid developments taking place in the different sections of fuel technology in every industrial country. Among the more important of the fuel problems awaiting solution are the pre-treatment and carbonisation of coal; the utilisation of fuel for generating electricity in industry and for domestic use; the treatment and utilisation of the so-called by-products of coal; atmospheric pollution, etc. Of equal importance are the education and training of personnel in different sections of fuel technology and the collection and co-ordination of information and statistics relative to the utilisation of fuel in industry.

The president of the Institute is Sir Alfred Mond, and the offices are situated at 53, Victoria Street, London, S.W.1. During the year an autumn meeting was held in November, at which Sir Alfred Mond delivered his presidential address, and a number of papers were read and discussed. It is hoped that, from January, 1928, monthly meetings will be inaugurated in London during the greater part of the year, and also in the provinces. The papers and discussions presented at these meetings will be published in the Journal of the Institute, which it is hoped to issue quarterly at the outset, and monthly as soon as finances permit.

In consequence of the conference there has been a considerable increase in the number of members, and there is little doubt but that the Institute is now firmly established and is taking its place amongst the technical institutions of high standing.

The Institute of Metals

During the past twelve months considerable progress has been made by the Institute of Metals in numerous directions. The membership has continued its steady increase, and the

papers read before the Institute have been numerous and well up to the high standard of those presented in the past. At the March meeting of the Institute, which was held in London, the president, Sir John Dewrance, K.B.E., read his presidential address, and 17 papers were presented. The 17th May Lecture was delivered by Sir Henry Miers, F.R.S., on "The Growth of Crystals in Supersaturated Solutions." The annual autumn meeting was held in Derby, September 6-9. The annual autumn lecture was delivered before a large and appreciative audience by Dr. Leslie Aitchison, B.Sc., F.I.C., whose subject was "Non-Ferrous Metals in Modern Transport." Thirteen papers were read at the Derby meeting.

The meetings of the six local sections of the Institute have been well attended, and numerous papers of practical interest have been read and discussed at these meetings. Mr. R. May, A.R.S.M., investigator to the Corrosion Research Committee, has continued his investigations on the problems connected with the corrosion and protection of condenser tubes. The committee's revised pamphlet on "Notes on the Corrosion and Protection of Condenser Tubes," which has been specially published for use by engineers, has been greatly appreciated, and large numbers of copies have been ordered by engineers and firms interested in the subject. During the past year the Institute has more than doubled its office accommodation, with the result that new library and reading rooms have been provided, which are a tremendous improvement upon those which existed in the old offices. They are quiet and comfortably furnished, and members are making increased use of the considerable library facilities available to them.

The Institution of Chemical Engineers

During 1927 the Institution of Chemical Engineers has consolidated its already well-established position, and the membership shows a further increase of about 20 per cent. At the annual corporate meeting, held in March, Sir Alexander Gibb was elected president, and Messrs. J. Arthur Reavell and W. A. S. Calder vice-presidents. Professor J. W. Hinchley and Mr. F. H. Rogers were re-elected respectively honorary secretary and honorary treasurer. The second examination for the Associate-Membership was held during June and July, there being eight entrants, of whom three were successful. The examination was conducted on lines similar to last year, there being a paper to be worked at home during June, followed by four papers worked in London under ordinary examination conditions, and a *viva voce* session. The examiners reported that the work of the candidates showed a distinct advance on that of last year, but there is still need, especially in the provinces, for the provision of additional educational facilities. Three-day conferences were held in March and December, when papers of exceptional interest in chemical engineering were read.

The presidential address, delivered in March by Sir Frederic Nathan on "Some Industrial Developments and the Chemical Engineer," aroused widespread comment, and other papers provoked considerable discussion. The president's reception was held on November 2, when Sir Alexander Gibb received about 400 members of the Institution and their friends at the New Princes' Galleries, London, W.1. A new departure was introduced in October, when a series of public lectures was inaugurated. Sir William Bragg delivered the first of these lectures at the Institution of Civil Engineers on Friday, October 28, on "Crystallisation," to a large audience.

The Oil and Colour Chemists' Association

The Association has made steady progress during the past year, not only in regard to the number of its members, but also in its publications and the variety of papers contributed. The Research Association of British Paint, Colour and Varnish Manufacturers, the formation of which was mentioned in last year's report, has commenced operations in well-found laboratories at Teddington, under the direction of Dr. L. A. Jordan. The Oil and Colour Chemists' Association is represented on the Council of the Research Association by its President, who, in addition, is chairman of the Technical Advisory Committee. Other co-opted members of the Technical Advisory Committee are Mr. J. A. Frome Wilkinson and Dr. J. J. Fox, both of whom are closely connected with the work of the Association. It is hoped that the existing

close connection between the two Associations will be further strengthened during the coming year by the publication of joint abstracts of scientific literature, relating to the paint, colour and allied trades.

The Sub-Committee and Panels of the British Engineering Standards Association have continued their work during the past year, and altogether some 40 specifications have already been issued. These specifications, which have been well received by manufacturers and users, are to be regarded as the first combined effort to standardise paint materials in this country. The scheme is by far the most ambitious which has yet been undertaken in any country, and the work is being closely watched throughout the world. The Oil and Colour Chemists' Association is fully represented on these bodies, both directly and indirectly. The Chairman of the Sub-Committee (Dr. J. Newton Friend), and the Chairmen of the three Panels (Mr. C. A. Klein, Dr. H. Houlston Morgan, and Dr. G. Rudolf) include two Past Presidents and one President of the Association. In addition, although representing other interests, numerous members of the Association are engaged in this work.

The Manchester Section of the Association, under the Chairmanship of Mr. J. B. Shaw, has continued to make steady progress, and the following papers have been read during the year: "Lake Dyestuffs and Their Application," A. W. C. Harrison; "The Constants of Colour: Hue, Purity and Luminosity," C. W. Gamble; "Cellulose Ester Varnishes: Their Manufacture, Properties and Application," S. Smith; "Standard Specifications for Pigments," C. A. Klein; "Some Problems of Varnish Films," R. S. Morrell; "The Application of Methods of Dyestuff Analysis to the Examination of Pigments and Lakes," A. G. Green. In addition, the Manchester Section is developing its social side very successfully.

The papers read before the Association in London were as follows: "Cadmium Colours and Their Application to the Paint Industry," H. W. D. Ward; "Further Notes on the Behaviour of Phenolic Resins," A. A. Drummond; "Researches on the Protection of Steel with Paint," J. A. Newton Friend; "The Yellowing of Linseed Oil," R. S. Morrell and S. Marks; "Some Physical Factors Influencing the Properties of Paint Pigments," A. de Waele; "The Scattering of Light by Suspended Particles," T. M. Lowry; "The Application of X-rays to Industry," G. Shearer. In October, a discussion on "Colour Standardisation and Testing in the Paint and Colour Industry" was held at the Royal Society of Arts, the discussion being opened by Dr. C. Beavis, followed by the President, Dr. L. C. Martin, Mrs. F. E. Lovibond, Dr. S. G. Barker, Dr. L. A. Jordan, Messrs. J. Guild, R. S. Horsfall, and others.

During 1928 the Manchester Section will receive papers from Dr. A. E. Everest and Mr. J. A. Wallwork on "Azoic and Other Insoluble Colours"; Dr. Stanley Smith on "Nitro-cellulose Lacquers—Recent Developments"; Dr. J. Newton Friend, "Researches on the Preservation of Iron and Steel with Paint"; whilst at the London meetings the following papers will be read: "Some Points in the Manufacture of Zinc Oxide," R. G. Daniels; "Malayan Damars, Part II," T. Hedley Barry; "Zinc Chromes," J. J. Fox; "Notes on Aeronautical Paints and Varnishes," E. W. J. Mardles; "False Equilibria," R. P. L. Britton; "Nitro-cellulose Lacquers," H. Hepworth.

In accordance with custom for the last three years, the Association will hold a Joint Discussion with the Incorporated Institute of British Decorators, when a problem of common interest will be discussed; the subject chosen this year being "The Painting of Plaster and Cement."

The Association has continued to be responsible for the production of the Section of the Annual Reports on the Progress of Applied Chemistry (1926), dealing with Paints, Pigments, Varnishes and Resins. The Section was prepared by Messrs. A. A. Drummond, J. Parrish, and S. S. Woolf, under the Editorship of the Hon. Editor of the Oil and Colour Chemists' Association. The Report for 1927 is also being prepared by the same contributors.

Among other social arrangements which have been made, special mention should be made of the visit on March 31, 1928, to inspect the paintings at the Houses of Parliament. These historical paintings are of particular interest to paint chemists, as they include examples of all the technical processes which have been explored in the attempt to discover the most durable method of mural painting under modern conditions.

Obituary

The obituary list for 1927 includes the following:—

January.—Mr. John Webster, the Home Office Analyst; Mr. E. J. Woolley, of James Woolley Sons and Co., Ltd.

February.—Professor Carl Graebe, who first synthesised alizarin; Dr. Luigi Casale, inventor of the Casale process of ammonia production.

March.—Dr. A. W. Crossley, first director of research to the British Cotton Industry Research Association; Professor D. Berthelot, of Paris; Professor Ira Remsen, the veteran American organic chemist; Mr. R. Stewart, of the firm of B. Laporte, Ltd.; and Dr. F. B. Power, chemist and pharmacologist.

May.—Dr. Geoffrey Weyman, chief chemist to the Newcastle and Gateshead Gas Co.; Professor G. Tschermak, mineralogist; Mr. T. W. Stainer Hutchins, of Electro Bleach and By-Products, Ltd.; Professor W. C. Williams.

August.—Professor H. R. Procter, the eminent leather chemist.

September.—Professor Archibald Liversidge; Sir W. S. Glyn-Jones; Professor R. A. Lehfeldt, in South Africa; Professor C. Pulfrich, the well-known authority on optics, of the Zeiss works, Jena.

October.—Professor S. Arrhenius, the Swedish physical chemist, a Nobel prizeman in chemistry; Dr. W. H. Sodeau; Mr. A. J. Squires, of the United Alkali Co.; Sir Gerard Albert Muntz.

December.—Professor Paul Groth, of Munich, famous for his work on chemical crystallography.

Year Books and Diaries

Scottish Dyes, Ltd., of Grangemouth and Carlisle, have issued a leather-bound diary and notebook. In addition to notes on daily wants, postal information, the diary contains many notes relating to dyes. There are fastness tables of Caledon colours, Solway colours, and Celatene colours, identification tables for various colours, instructions for dyeing with various dyes, paper and straw dyeing, calico and wool printing, etc. Finally, there are notes on the hardness of water, first aid, etc. This publication should be of great value to the dyeworks chemist.

The Year Book for 1928 of the Colour Users' Association, bound in leather, contains for so handy a pocket volume a remarkable collection of facts and figures relating to the dyestuffs industry, with a list of the members of the Association and particulars of various dyestuffs organisations. In an introductory note to users of dyestuffs, the opinion is expressed that for national security it is essential that synthetic colour-making factories should be in existence and be maintained in operation with their staffs of chemists and other experts in this country, and that this should be brought about without placing the textile and other colour-using industries in an unduly disadvantageous competitive position.

The Staveley Coal and Iron Co., Ltd., of Chesterfield (whose coloured genealogical tree illustrating the products of coal is already on many an office wall), issue a good class leather bound pocket book and diary. In addition to a mass of valuable statistical matter, it contains a list of the company's products as tar distillers and chemical manufacturers, which illustrates the extensive range of the company's activities.

The Scientists' Reference Book and Diary for 1928 (price 3s. 6d.) has been published by Jas. Woolley Sons and Co., Ltd., of Manchester. The diary portion contains many useful notes for the year 1928. The reference section (p. 186) contains a large amount of information, there being sections, among others, dealing with barometry, thermometry, hydrometry, chemistry and physics, atomic weights and other physical constants, factors for analyses, indicators, first aid, weights and measures, etc. In addition there are numerous useful tables, including solubilities, specific gravities, boiling and melting points, logarithms, mensuration tables. This publication should prove of great value and convenience to the chemist.

Crossley Brothers, Ltd., of Manchester, makers of Crossley engines, have issued a tear-off wall calendar, boldly printed and of handsome appearance.

Outlets for Ammonia—Present and Prospective

By V. N. Morris

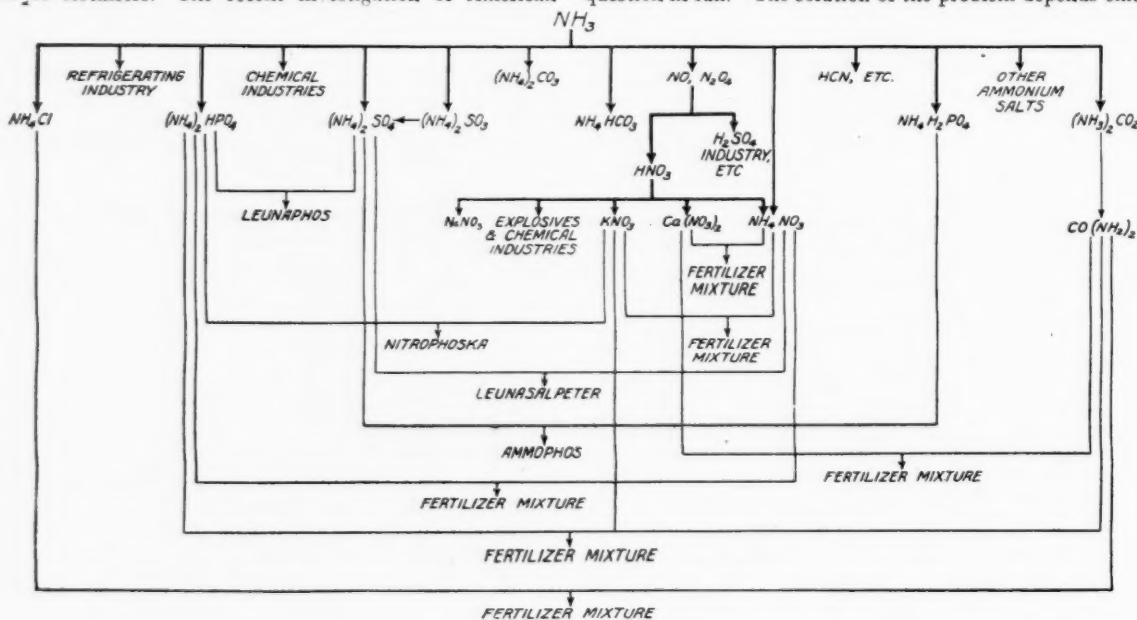
The author, a member of the staff of the United States Fixed Nitrogen Laboratory, at Washington, reviews in an article in Industrial and Engineering Chemistry the present position of the nitrogen industry throughout Europe and America mainly, and discusses the prospects of opening up new fields and uses to absorb the ever-increasing output.

LESS than six years ago the first successful synthetic ammonia plant in America started operation. Since then our progress along the line of nitrogen fixation has been commendable. At the end of 1926 eight plants in the United States were either producing or were ready to produce synthetic ammonia. Notwithstanding the possibility of supply surpassing demand, expansion and construction are continually without sign of abatement. The Allied Chemical and Dye Corporation, for instance, has recently announced plans for a large plant to be erected at Hopewell, Va. It is understood that the output of this plant will go into fertilisers. It is also believed that a considerable expansion of the Lazote plant at Belle, W. Va., is soon to be undertaken. It is known that part of the output of this plant will eventually be marketed in the form of fertilisers. The recent investigation of American

The output of several small plants in France is soon to be enhanced by that of the French Government at Toulouse. A recent announcement states that this 60,000-ton plant, the completion of which has been delayed somewhat, will begin operation this year. It is also known that several other countries, including Italy, Sweden, Spain, Brazil, Switzerland, Belgium, Norway, and Poland, have recently completed synthetic ammonia plants, replaced other methods of nitrogen fixation by that of synthetic ammonia, or made plans for an immediate entrance into the field.

Development of New Outlets

What disposition is to be made of this rapidly increasing output of ammonia? No single statement can answer this question in full. The solution of the problem depends chiefly,



THE OUTLETS FOR AMMONIA.

conditions by German interests has made apparent another possible addition to the list of manufacturers of synthetic ammonia in this country. It is also worthy of mention that the plants of the Commercial Solvents Corporation and of the Great Western Electrochemical Co. were scheduled to be completed and to start operation during the course of the present year.

In other countries the developments have been just as noteworthy as in the United States. According to the director of the Stickstoff-Syndikat,¹ Germany, whose present production of synthetic nitrogen compounds is much greater than that of the rest of the world combined, will have a total output during the fertiliser year 1926-7 of over 500,000 tons of ammonia. Further expansion of this large capacity is already planned. Great Britain's largest plant, that of Synthetic Ammonia and Nitrates, Ltd., was expected to have its capacity increased to about 65,000 tons of nitrogen by June of this year. Installations have also been planned for Australia and certain other British colonies. Japan, which has heretofore been a rather large importer, has an extensive construction programme—so extensive, in fact, as to arouse speculation regarding the possibility of her planning to make a bid for a part of the hoped-for Asiatic fertiliser market.

however, on the development of new outlets for ammonia—new not only in the sense of the development of products differing from those into which it has heretofore been converted, but new also from the point of view of the fields of utilisation of all such products, whether new or old. This last-mentioned extension must depend to a considerable extent upon a campaign of education. In the discussion which follows, stress is laid upon these newer outlets, faith in which is largely the basis for the rapid expansion of the synthetic ammonia industry. The discussion should not be considered as being limited to synthetic ammonia. The fact remains, however, that the synthetic product has not only cut into the market for by-product ammonia and brought about a steady decline in the production of Chilean nitrate, but is even beginning to replace the arc process of nitrogen fixation, which has been in operation for so many years in Norway.

The accompanying chart gives a picture of the various outlets for ammonia. It shows certain potential ones as well as those actually developed. It should be borne in mind that nearly all the salts shown can, if marketed in a suitable physical condition, be used as fertilisers. The various uses of a given compound are not shown except in cases where omitting them would give the impression that the compound served only as an intermediate for the production of some other substance. Fertiliser mixtures containing two nitro-

¹ Bueb, THE CHEMICAL AGE (London), 14, 494 (1926).

genous salts are also shown. The chart indicates the ingredients of the various mixtures. Such mixtures as are commonly marketed under given trade names are indicated by their trade names.

Oxidation to Nitric Acid

Outstanding among the prospective developments, particularly from the American point of view, is that of the oxidation of ammonia. Germany and other European countries have jumped ahead of the United States in the production of nitric acid and nitrates from ammonia. Considering the world as a whole, it is surprising that the oxidation of ammonia has lagged so much behind the synthesis of this product. With the firm establishment of the synthetic industry in this country as a basis, and the price difference between ammonia and nitrates as an economic stimulus, an advance into the field of synthetic nitrates may be expected.

It has been learned from good authority that the present production of synthetic nitric acid in America is about 25 tons per day. The makers of by-products as well as synthetic ammonia are known to be actively interested in the possibilities inherent in the oxidation of the product. The E. I. du Pont de Nemours Co. is already operating a plant for the production of nitric acid from ammonia, and other companies are apparently soon to obtain their acid by a similar procedure.

A brief review of progress in other countries will reveal how effectively in general synthetic nitric acid has been able to compete with the product made from sodium nitrate. Germany is at present quite independent of Chilean nitrate. Her exports attest to the fact that the production of synthetic nitrates is a firmly established industry. In Great Britain the output of the United Alkali Co.'s ammonia plant is being oxidised to nitric acid, and some of the larger gas companies are reported to be interested in the possibility of obtaining a profitable outlet for their ammonia *via* the oxidation route. The recent Swedish plans call for the production of 1,500 tons of concentrated nitric acid per year, with a possible maximum of 6,000 tons. Italy and France are also known to have oxidation installations in operation. The plans of Russia, Poland, and Czechoslovakia are stated to call for at least a partial oxidation of the output of their synthetic ammonia plants. The outlook for Chilean nitrate in the nitric acid industry of Europe is certainly not very bright.

Synthetic Nitrates

Improvements in the technology of manufacture cannot fail to have a beneficial influence on the output of synthetic nitric acid and nitrates. Among the possible improvements which may be expected are those which would result from absorption in a refrigerated system, catalysis of the re-oxidation of the nitric oxide liberated during absorption, operation under pressure, and oxidation with oxygen or oxygen-enriched air.

Since a large part of the cost of the installation of an ammonia oxidation plant can be charged to the absorption towers, any process tending to lessen the tower requirements is much to be desired. In the towers part of the nitrogen tetroxide absorbed is released again as nitric oxide. The slow re-oxidation of this nitric oxide is generally stated to determine the rate of absorption in the ordinary systems. The effective catalysis of this reaction, the possibilities of which are now being investigated in this laboratory, would obviously result in a considerable saving. It has long been known that good absorption and rapid oxidation result from the use of lower temperatures. It is claimed that sufficient cooling will do away with the necessity of absorbing the end gases in a soda solution. The advantages to be expected from such a process have recently been discussed by Toniolo.²

Increasing the oxygen content of the air mixed with ammonia is another process having promising possibilities for certain cases. Although it appears that absorption should be benefited by such a modification, since dilution by nitrogen adds to the difficulty of the absorption of the oxides, the fact remains that the air has not been enriched at certain plants where oxygen is readily available. A decided disadvantage resulting from the use of a mixture containing a higher percentage of oxygen arises from the detrimental effect of excess oxygen on the platinum catalyst. In such plants it has been found to be just as satisfactory, if not more so, to add the

oxygen to the absorption towers. Another deterring factor in the development in this direction has been the knowledge that explosive mixtures of ammonia and oxygen may easily be obtained. According to the claims of patents recently granted to Cederburg,³ means of avoiding this explosibility have been discovered. By making use of oxygen in place of air, it is possible to obtain nitrogen oxides in a more concentrated form. Since the possibility of having available much cheaper oxygen in the future does not appear at all remote, much may be expected of such a process.

Of the possible ways of disposing of ammonia *via* the nitrogen oxides, that having to do with the chamber process of sulphuric acid manufacture appears at present to be the most important. The fact that the sulphuric acid industry is capable of providing an all-year market for nitrogen oxides should be an added incentive towards ammonia oxidation, since the demand for ammonia as such is somewhat seasonal. Work along this line is being actively promoted in the United States at the present time, and a number of installations are already in successful operation. In Europe this practice is now almost universal.

Outlets for Nitric Acid and Nitrates

The explosive and fertiliser industries are the largest consumers of nitric acid and nitrates. Barring an unforeseen national emergency, no very rapid expansion of the explosive industry is anticipated. As soon as production and economic conditions permit, however, we may expect American synthetic nitrates to enter the fertiliser market. It seems, in fact, that any further considerable expansion of the atmospheric nitrogen industry in this country must inevitably lead to a fertiliser outlet. Since "nitrate" nitrogen is more readily available than other forms of nitrogen, a certain minimum of this form is desirable for mixed fertilisers. Curtis⁴ has recently discussed the problem from this point of view.

Although the major portion of the synthetic fertilisers to be produced in America at first will probably be in the form of ammonium salts, there are certain nitrates whose possibilities are worthy of mention. Among these are ammonium nitrate, calcium nitrate, potassium nitrate, sodium nitrate, and various mixtures containing one or more of these compounds as ingredients.

Ammonium Nitrate

Ammonium nitrate, with its high content in both ammonia and "nitrate" nitrogen, would be a highly prized fertiliser were it not for its explosibility and hygroscopicity. It was one of the first synthetic fertilisers put out by the Germans and has been on the market for several years, usually in the form of mixtures with other salts, such as ammonium sulphate, potassium chloride and nitrate, calcium sulphate, and calcium nitrate. A method for producing a fine-grained crystalline form of ammonium nitrate has recently been developed in Europe. In this process the hot liquors, containing 90 to 95 per cent. of ammonium nitrate, are run into a sort of dough-mixer, in which a blast of cold air is passed continuously over the crystallising mass. According to another proposal,⁵ the heat of reaction of ammonia and nitric acid is utilised for the evaporation of at least a portion of the water present. Considerable work has been done both in this country and abroad on the graining and coating of ammonium nitrate.⁷ Symmes⁸ has recently patented a process for obtaining a granular product by spraying into a gaseous cooling medium. That interest in ammonium nitrate is not confined to the United States and Germany is manifested by recent reports from Italy, England, Norway, and Sweden. The plants of Sweden call for the production of 3,000 tons annually, whereas the Norwegians are reported⁹ to be ready to begin the manufacture of this salt from synthetic ammonia.

Calcium Nitrate

Although the high hygroscopicity of calcium nitrate makes its use less attractive to American than to European farmers, this salt has been placed on the American market by German interests. Germany has within the last year or two taken

⁴ British Patents 244,134 and 246,889 (1926).

⁵ "Mineral Raw Materials for the Fertiliser Industry," Natl. Fert. Assoc., p. 45 (1926).

⁷ Toniolo, British Patents 247,227 and 247,228 (1925).

⁸ Krase, Yee, and Braham, *Chem. Met. Eng.*, 32, 241 (1925).

⁹ U.S. Patent 1,613,334 (1927).

² THE CHEMICAL AGE (London), 16, 171 (1927).

¹ *Chem. Met. Eng.*, 34, 92 (1927).

the lead away from the Scandinavian countries in the production of calcium nitrate for agricultural purposes. Necessity has led to a technology in manufacture which has provided a product as acceptable in many respects as is the average sodium nitrate available. As has been pointed out by Bueb,¹ calcium nitrate provides the nitrate radicle in the form of a compound with a soil-improver, calcium, instead of with sodium, which is not only of no value in the soil but is even harmful to some extent. The desirability of manufacturing calcium nitrate and ammonium sulphate together is already being realised. A process for the manufacture of ammonium sulphate which is growing in favour—viz., that of treating calcium sulphate with ammonia and carbon dioxide—gives calcium carbonate as a by-product. This carbonate can be used to advantage in the production of calcium nitrate. Taking everything into consideration, it does not seem probable that calcium nitrate will provide the least of the several prospective outlets for ammonia, even in America.

The older form of calcium nitrate, which is decidedly hygroscopic, which cannot be readily mixed with other materials, and which has to be shipped in air-tight wooden kegs, is being superseded by a new product which has a higher nitrogen content, can be shipped in specially treated bags, and has been improved somewhat in the matter of hygroscopicity. Several methods for improving the quality of the product have recently been proposed. According to one of these,¹⁰ a form of calcium nitrate which does not readily become moist may be obtained by the intimate mixing of a small proportion of the hydrate of calcium nitrate with the product resulting from the almost complete dehydration of a solution of the salt. In another proposed manufacturing improvement the highly concentrated solution is brought in contact with rollers heated to 250° C., the solid salt being removed by scrapers. Another process¹¹ for which advantages are claimed is that of adding a small percentage of ammonium nitrate to the saturated solution of the calcium salt. Crystallisation is stated to occur much more readily after such an addition. Spraying the concentrated solution through a nozzle is one method proposed for obtaining a granular product and one having improved properties. It has been claimed that certain of these new forms of calcium nitrate are less hygroscopic than the ordinary product. This claim has recently been disputed by Ross, Mehring, and Merz.¹² These authors point out that the recent German product has a greater capacity for moisture since it is marketed in a form having only about two molecules of hydrated water.

Mixtures of calcium nitrate with other substances have been proposed as fertilisers. The mixture of this salt with urea in varying proportions has been the subject of a recent patent.¹³ Other possibilities include mixtures of calcium nitrate with certain of the calcium phosphates. This laboratory now has under investigation a process in which the nitric oxides from ammonia oxidation are absorbed in a suspension of phosphate rock, the initial products desired being monocalcium phosphate and calcium nitrate. No decision regarding the possibility of making industrial application of this process can be made until certain additional phases of the problem have been investigated.

Potassium Nitrate

The conversion of ammonia to potassium nitrate offers still another means of disposing of the former substance. Since potassium nitrate possesses very satisfactory physical properties and contains two of the major nutrient elements desired for fertilisers, the problem of its utilisation in agriculture is largely an economic one. The most recent American contribution to the development of a satisfactory method for the manufacture of this salt is that of Ross and Mehring,¹⁴ of the Bureau of Soils. According to their process, nitrogen tetroxide obtained from the oxidation of ammonia is absorbed in a saturated solution of potassium chloride. In the proposed cyclic operation of the process potassium nitrate is crystallised

out and hydrochloric acid is removed as a by-product. The inventors are now conducting a more thorough investigation of this process, the commercial applicability of which has aroused the active interest of one of America's largest chemical manufacturers.

Ammonium Sulphate

As previously mentioned, it is probable that in America the fertiliser manufacturers will continue for some time to give more attention to ammonium salts than to synthetic nitrates. One ammonium salt, the nitrate, has already been discussed, and others have been mentioned in connection with various fertiliser mixtures.

The most common nitrogenous fertiliser, with the exception of Chilean nitrate, is ammonium sulphate. In America and most other countries ammonium sulphate has been manufactured in large quantities from by-product ammonia and sulphuric acid. Since 1923 the Germans have been sending ever increasing quantities of the synthetic salt into the world market. The effect has been to reduce the high prices prevailing prior to that date. A double salt, ammonium sulphate-nitrate, sold under the name of Leunasalpeter, is another widely exported German product.

The fact that an exportable surplus of ammonium sulphate is already being made from by-product ammonia in America has been used as an argument against the possibility of synthetic ammonias being utilised for this purpose. The uniformity and improved appearance of the synthetic product, however, may yet allow it to compete, particularly if a cheaper source of the sulphate radicle can be developed. In connection with such a cheaper source the process recently discussed by Jackman¹⁵ before the Michigan Gas Association is worthy of mention. This process involves the interaction of gypsum and ammonium carbonate, and is claimed to be more economical than other methods. A plant has been constructed to make use of the process in connection with a gas works at Battle Creek, Mich. For the full development of such a process it has been pointed out by British critics¹⁷ that there are certain difficulties which will have to be overcome. In Germany, where a cheap source of sulphur is lacking, ammonium sulphate is made from gypsum, carbon dioxide, and ammonia. The correlation of this process with the manufacture of calcium nitrate has already been mentioned. Freeth¹⁸ has stated that the process of making ammonium sulphate from calcium sulphate is used at the Billingham plant in England. The consequent depressing effect on the sulphuric acid industry of that country has recently been discussed by Parrish.¹⁹ The British utilise the mineral, anhydrite, rather than gypsum for this purpose. Anhydrite is said to be much more suitable than gypsum, since its content of calcium sulphate is higher and it is more readily susceptible to reaction with ammonium carbonate or bicarbonate. Deposits of anhydrite are rather widely distributed throughout the United States.

The possibility of using nitre cake in the manufacture of ammonium sulphate has been discussed by Moliter.²⁰ In this process ammonia and water are added to the nitre cake obtained from a nitric acid plant. After certain intermediate operations, considerable normal sodium sulphate is crystallised out. The ammonium sulphate (contaminated by a little of the sodium salt) is later removed by further evaporation and crystallisation.

Another process which has aroused some little interest in England at least is that of West, Jaques, and Morgan.²¹ Although the ultimate objective is ammonium sulphate, the primary product is the sulphite. The process consists in allowing ammonia to react with dilute sulphur dioxide, such as weak burner gases, in presence of water vapour. Under easily regulated conditions solid ammonium sulphite is produced in a form stated to be very sensitive to oxidation by the air. Certain drawbacks to the method have been mentioned by Parrish.¹⁹

¹⁰ Farbwerke vorm. Meister, Lucius, und Brüning, British Patent 242-990 (1924).

¹¹ Badische Anilin und Soda Fabrik, German Patents 429,477 and 429,478 (1924); British Patent 249,370 (1925).

¹² Ind. Eng. Chem., 19, 211 (1927).

¹³ Johnson, British Patent 246,377 (1925).

¹⁴ U.S. Patent 1,604,660 (1926).

¹⁵ Chem. Met. Eng., 33, 484 (1926).

¹⁷ THE CHEMICAL AGE (London), 15, 267 (1926).

¹⁸ Ibid., 16, 9, (1927).

¹⁹ Ibid., 16, 10 (1927).

²⁰ Chem.-Ztg., 50, 465 (1926).

²¹ THE CHEMICAL AGE (London), 14, 201 (1926).

Ammonium Phosphates

The problem of the selection of an ammonium product which can be manufactured cheaply enough to compete with ammonium sulphate has been the subject of discussions by Curtis,²² Maxted,²³ and others. The phosphates appear quite attractive in this connection, since they provide phosphorus as well as nitrogen in a readily available form. Both the mono- and diammonium phosphates can be used as fertilisers. The latter salt has been favoured by the Germans, but the former, being less hygroscopic and having a higher ratio of phosphorus to nitrogen, is more suited to American conditions.

It has been found possible in general to mix the ammonium phosphates with other fertiliser materials. A mixture with potassium nitrate, Nitrophoska, has already been discussed. One of the grades of Ammophos, a product manufactured in America, consists of a mixture of ammonium sulphate and monoammonium phosphate,²⁴ while the Leunaphos of the Germans is similar except for the substitution of the di- for the mono-salt. According to Daugherty,²⁵ the manufacture of Leunaphos on a large scale did not begin until after the completion of the phosphoric acid plant at Piesteritz in the late spring of this year. Other German products consist of the phosphate mixed with ammonium nitrate²⁶ in one case, and with potassium chloride¹² in another.

It is quite generally recognised that a rapid increase in the output of ammonium phosphates awaits only a cheaper phosphoric acid. In this connection the possible utilisation of the Liljenroth²⁷ process has aroused considerable interest. In the operation of this process, yellow phosphorus is first produced in an electric furnace. Phosphoric acid is then obtained by blowing the vaporised phosphorus mixed with steam over a catalyst at 1000° C. The hydrogen, which is simultaneously generated, can be used to advantage in the synthesis of the ammonia, which is then combined with the phosphoric acid. Possible improvements of this last step have been outlined in two recent patents, the essential features of which have been discussed by Parrish.¹⁹ The Germans are already taking advantage of this process. By utilising part of the power available at the Piesteritz cyanamide plant, they were by the middle of 1927 in a position to produce P₂O₅ at the rate of 6,000 tons per year.²⁸

Compounds of Ammonia and Carbon Dioxide

In addition to the phosphates, the solid compounds which can be produced from ammonia and carbon dioxide have possibilities of becoming rivals of the sulphate. These compounds are ammonium carbamate and urea. If water is also included in the system, two others, the carbonate and bicarbonate, may be added to the list.

Although no great amount of attention seems to have been devoted to three of these—the carbamate, carbonate, and bicarbonate—it has been reported that one of the largest manufacturers of synthetic ammonia in America converts part of its product into the last-named salt. The possibilities of these three compounds have recently been reviewed by Maxted.²⁹ Since carbon dioxide is available in large quantities whenever the hydrogen for the synthesis of ammonia is obtained by the water-gas catalytic process, the lack of materials should never be a source of difficulty in the manufacture of such compounds. On account of the instability of both carbonate and carbamate, most of the investigation has been concerned with the production of urea, a more stable compound. A recent Badische patent³⁰ states that the instability of ammonium bicarbonate can be attributed to the presence of small quantities of the carbonate and carbamate. When the salt is prepared free from these impurities, the loss of ammonia on storage is said to be very slight. That the carbamate can also be prepared in stable form is

indicated by the claims of a patent recently granted to British investigators.²⁹

Although Germany seems to have been the only country which has produced urea on a commercial scale, others have been actively investigating the project. According to Bueb¹ the problems connected with the successful manufacture of urea were solved by the Germans in 1924. It now seems doubtful whether their solution was as successful as reported, although German urea is at present on the American market. The exact details of the German process are not available. The synthesis of urea in general has, however, been thoroughly discussed by Matignon and Frejacques.³⁰ The results of certain phases of the investigation which is being conducted in this country have recently been published by Clark and Krase³¹ and by Krase and Hetherington.³² Casale³³ has recently patented a process for manufacturing urea. According to his method, carbon dioxide is brought into contact with synthetic ammonia just as the latter leaves the catalyst chamber, the purpose of this procedure being to make use of the thermal and volume energy contained in the gas. The urea formed is cooled in the lower part of the reaction chamber.

Both advantages and disadvantages may be listed for urea. Its tendency to take up moisture, although strong, is less than that of Chilean nitrate. According to MacDowell, field tests have indicated that urea is not superior to ammonium sulphate as a general fertiliser. Bueb³ states, however, that its application is destined to be very successful with such crops as tobacco and hops, and with vines, in gardens, and on pasture lands. Since its nitrogen content is nearly 47 per cent., its use in America, where freight charges are important, should increase rapidly, provided the necessary propaganda is forthcoming. Alexander³⁴ has recently directed attention to the fact that its use in fertilisers is not the only outlet for synthetic urea. It can also be utilised in the manufacture of synthetic resins and artificial (non-breakable) glass. In summary, it can apparently be safely stated that the outlook for synthetic urea is bright.

Propaganda

According to Bueb,¹ agriculture has always been the centre of the German propaganda efforts. The first step was a widespread series of ocular demonstrations of the effect of nitrogen in promoting the growth of plants. Then followed accurate determinations of the increases in the yields of various crops, and demonstrations by means of model farms of the profits to be gained from utilisation of the most modern scientific experience. Although certain projects of a propaganda nature which the Germans had contemplated for China may have been somewhat fantastic, there is no doubt but that the methods they used at home were quite successful.

While Speyer³⁵ has stated that low price and adaptable variety of form have made the major contributions towards creating a demand for nitrogen in England, certain efforts along the line of additional propaganda have been carried out. On December 1, 1926, the newly created Nitram, Ltd., took over the selling and propaganda functions of both Synthetic Ammonia and Nitrates, Ltd., and the British Sulphate of Ammonia Federation. A recent report³⁶ states, furthermore, that both the British Government and the new big chemical merger, Imperial Chemical Industries, Ltd., are concentrating upon research from an agricultural point of view, the object being to assist and educate the farmer.

There has been a rumour of the possible establishment of a nitrogen institute in the United States. One of the functions of such an institute would undoubtedly have to do with propaganda. Just what form this propaganda should take in America is a question outside the scope of this paper. The fact remains, however, that the per capita consumption of nitrogen in this country is low. Education of the prospective user of nitrogen cannot fail to have a beneficial influence upon the demand for this substance.

²² *Am. Fertilizer*, **64**, No. 13, 67 (1926).

²³ *THE CHEMICAL AGE* (London), **16**, 6 (1927).

²⁴ Braham, U.S. Dept. Commerce, *Trade Information Bull.*, **240**, p. 36 (1924).

²⁵ *Ibid.*, **451**, 16 (1927).

²⁶ I.G. Farbenindustrie Aktien-Gesellschaft, British Patent 256,972 (1925).

²⁷ U.S. Patents 1,594,372 and 1,605,960 (1926).

²⁸ British Patent 244,645 (1925).

²⁹ Synthetic Ammonia and Nitrates, Ltd., British Patent 258,048 (1925).

³⁰ *Bull. Soc. Chim.*, **31**, 307 (1922).

³¹ *Ind. Eng. Chem.*, **19**, 205 (1927).

³² *Ibid.*, **19**, 208 (1927).

³³ British Patent 241,123 (1925).

³⁴ *THE CHEMICAL AGE* (London), **16**, 4 (1927).

³⁵ *Ibid.*, **14**, 496 (1926).

³⁶ *Ibid.*, **16**, 137 (1927).

From Week to Week

DR. G. M. DYSON has been appointed senior lecturer in chemistry at Loughborough Technical College.

A MEDAL IN HONOUR OF BERTHELOT has been awarded by the Seventh Congress of Chemical Industry in Paris recently to George Claude.

A COMBINED CHEMICAL AND AVIATION defence organisation, with a military chemical laboratory at Krasnodar, is stated to be intensifying its activity in Russia.

DR. J. GORDON PARKER, on the occasion of his retirement from the Leathersellers' Technical College, has been presented with a recording thermograph and barograph.

STEIN BROTHERS, LTD., of Ocean House, 24-25, Great Tower Street, London, E.C.3, advise us that their new telephone numbers are as follows: Royal 8724 and 8725 (private extension to works).

THE NEW CHEMISTRY BUILDING of the University of Maryland was opened in November, the inaugural address being given by Dr. Edgar F. Smith, formerly Provost of the University of Pennsylvania.

GERMAN CAUSTIC SODA EXPORTS declined during the first eight months of 1927 to 6,437 metric tons, from 10,518 tons during the corresponding period of 1926. Over half of the 1927 exports were destined for the Netherlands.

THE STATE INSTITUTE OF APPLIED CHEMISTRY at Leningrad is stated to have developed an electro-thermic process for the manufacture of yellow phosphorus, phosphorites, apatite, common sand, and Donetz coal being the materials used.

BROTHERTON AND CO., LTD., are opening an office on Monday, January 2, 1928, at 53, King Street, Manchester. The Manchester branch, controlling local stocks of hydrosulphites, etc., will be under the management of Mr. F. T. Cutler, and with him will be associated Mr. R. B. Penrose.

UNIVERSITY NEWS:—*Cambridge*: Dr. M. Dixon, of Emanuel College, has been appointed University lecturer in biochemistry.—*Oxford*: Mr. C. G. T. Morison, reader in agricultural chemistry, has been appointed to an official studentship at Christ Church College.—*Mr. J. H. Wolfenden* has been appointed lecturer in chemistry at Exeter College.

THE FOLLOWING OFFICERS WERE RECENTLY ELECTED by the American Institute of Chemical Engineers at the twentieth semi-annual meeting: Mr. E. R. Weidlein, president; Mr. A. H. White, vice-president; Mr. H. C. Parmelee, secretary; Mr. M. H. Ittner, treasurer; Mr. D. Wesson, auditor; Messrs. J. V. N. Dorr, J. R. Withrow, W. C. Geer, and R. T. Haslam, directors.

THE COMMISSIONERS OF CUSTOMS AND EXCISE have prepared a notice (No. 161) explaining the arrangements which have been made with the consent of the Postmaster-General, for the importation of certain *bona-fide* trade samples of dutiable chemicals by sample post. Copies may be obtained by importers and others concerned on application to the Secretary, Custom House, London, E.C.3.

AT A MEETING OF THE COUNCIL of the Cornish Institute of Engineers on December 17, it was announced that the Royal Geological Society of Cornwall, the Royal Cornwall Polytechnic Society and the Cornish Chamber of Mines wished to join in a formal invitation to the Institute of Mining and Metallurgy to hold its summer meeting at Camborne next year, and that the Royal Institution of Cornwall would probably also co-operate.

PROFESSOR C. B. COLLIP, one of the co-discoverers of insulin, has been appointed professor of biochemistry in the medical faculty of McGill University, Montreal. It was Professor Collip who made the first insulin that was ever used on a patient. Though but 35 years of age, Professor Collip is recognised as one of the outstanding biochemists of America. Recently he has made further discoveries in connection with the parathyroid glands and the treatment of tetany.

ARTIFICIAL SILK NEWS.—Rumours are current in Preston that Courtaulds propose to erect a factory at Ashton-on-Ribble. It is understood that a representative of the firm has visited the town as one of a number of places, among which Blackburn and Lancaster are also mentioned.—The amount of artificial silk imported into British India in the first half of the fiscal year, ending in September, was just under 2,000,000 lb., with a value of 78½ lakhs of rupees, as against 38½ lakhs in the corresponding period in 1926. The British share rose from 254,000 lb. to 1,236,000 lb.

THE CHEMICAL SECTION of the American Association for the Advancement of Science, which held its meetings this week, heard the following papers among others: "A Glimpse of Chemistry Here and Abroad," by Professor L. W. Jones, who has been visiting Europe; "Valence," by Professor W. A. Noyes; "Separations by the Ionic Migration Method," by Professor J. Kendall, F.R.S.; and "Ionic Antagonisms in Colloid Systems," by Professor H. B. Weiser. On Thursday, Friday, and to-day the Second Symposium on Organic Chemistry of the American Chemical Society was held at Columbus, Ohio.

THE MATHIESON ALKALI WORKS of New York have acquired the ammonia business of the B. P. Clapp Co., of Cincinnati.

Chemical Markets, the American industrial chemical journal, will, as from the beginning of January, 1928, be published monthly instead of weekly.

MR. F. WILDBLOOD, chairman of the Blythe Bridge Colour Works, has recently retired from the staff of the Shelton Iron, Steel and Coal Co. after 53 years' service.

RECENT WILLS INCLUDE:—Mr. Charles Edward Hawthorne, managing director of the Liverpool Building Material and Cement Co., £11,152 (net personalty £10,035).

THE CHEMICAL STAFF of the Newcastle and Gateshead Gas Co. held their annual dinner in Newcastle on December 23, the chief chemist, Mr. L. H. Sensicle, being in the chair.

A FIRE caused very extensive damage to a building of one floor used as a distillery by Standard Synthetics, Ltd., chemical manufacturers, at Queen Street, Hammersmith, London.

THE UNITED JAPANESE CHAMBERS OF COMMERCE have decided to promote a large exhibit at the forthcoming Leipzig Spring Fair which commences on March 4, 1928. The amount of space already definitely booked is 1,800 square feet.

BENZOL-VERBAND G.m.b.H., of Bochum, and the Benzol Vereinigung des Ostens G.m.b.H., Berlin, which together control nearly the whole of the German benzol production, have formed an agreement for co-operation in price and sales policy.

THE DIRECT PRODUCTION OF STEEL from ore at the Hoesch Steel Works is stated now to have passed laboratory tests and reached a practical stage. A plant with a capacity of 30 tons is being erected, and is expected to be in operation next June. A cheapening of production by 30 per cent. is claimed.

MR. T. S. MARSH, works manager of the Netham Works, Bristol, of the United Alkali Co., retired recently after 39 years' service with the company, which he joined when it was the Netham Chemical Co., in 1888. He was presented with a handsome silver tray by Mr. J. Bernard, of Imperial Chemical Industries, Ltd.

NOMINEES FOR THE PRESIDENCY of the American Chemical Society are Dr. C. A. Browne, of the United States Bureau of Chemistry and Soils; Professor Moses Gomberg, of the University of Michigan; Dr. Irving Langmuir, of the research laboratory of the General Electric Co., of America; and Dr. S. W. Parr, emeritus professor of industrial chemistry in the University of Illinois.

THE MOREHEAD GOLD MEDAL of the International Acetylene Association of America has been presented to the Underwriters' Laboratories, Inc. The medal is presented annually for exceptionally meritorious service in the production and utilisation of calcium carbide and acetylene. Mr. L. E. Ogden, of the Oxweld Acetylene Co. of New York, has been elected president of the Association or 1927-28.

AN EXPLOSION followed by fire occurred on the morning of Thursday, December 22, at Southport (Lancs) Gasworks at Growlands, where the gas supply for the town is generated. The explosion took place in the meter house connected to the main supply, and one of the gasometers had a huge rent torn in its upper surface. A portion of the gasworks near the meter house was destroyed, and the meter house roof and part of the walls were blown away.

SCARCITY OF BROMINE during the world war led to the establishment of a plant in Tunis. After meeting with only a small degree of success, a French company elaborated a plan to exploit the salt lakes in the Crimea, and in 1917 six bromine towers were built. Due to political disturbances, operations were suspended shortly after the plant was finished, and were not resumed until 1923-24. Abundance of raw material, existing plant equipment and the relatively high prices ruling for the products, should make this plant an important potential supplier of bromine, magnesium chloride, and magnesium carbonate. The high prices of chlorine delivered at the plant have been a heavy burden, and plans are being considered to install an electrolytic chlorine plant on the premises.

THE EIGHTEENTH ANNUAL EXHIBITION of the Physical and Optical Societies will be held on January 10, 11 and 12, 1928, at the Imperial College of Science and Technology, Imperial Institute Road, South Kensington, and will be open in the afternoon from 3 p.m. to 6 p.m., and in the evening from 7 p.m. to 10 p.m. More than eighty firms will be exhibiting in the trade section this year, and in addition there will be a group of research and experimental exhibits by Fellows of the Societies, research laboratories and institutions, and others. Historical exhibits will also be included. The discourses in connection with the exhibition will be given at 8 p.m. on each evening. Members of societies may obtain tickets from their secretaries and others from the Secretary of the Physical and Optical Society, 1, Lowther Gardens, Exhibition Road, London, S.W.7.

Obituary

MR. SPENCER STANFORD, for many years associated with the Whitecrook Chemical Works, Clydebank.

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STARCH.—Kinetic studies on the conversion of starch to paste. I. The cold conversion of starch into paste. W. Ostwald and G. Frenkel. *Kolloid-Zeit.*, November, pp. 296-312.

Miscellaneous

CEMENT.—Studies on the hydration of cement. II. Microscopic study on the hydration of rapid hardening cements. K. Kumagai and T. Yoshioka. *J. Soc. Chem. Ind. Japan* (supplement), October, pp. 176-177B (in English).

Tests on fused Portland cement and aluminous cement. I. Yamazawa. *J. Soc. Chem. Ind. Japan* (supplement), October, pp. 177-178B (in English).

Studies on the modulus of rupture of cement mortar. S. Nagai. *J. Soc. Chem. Ind. Japan* (supplement), October, pp. 178-179B (in English).

GENERAL.—Studies on the inflammability of hydrogen. V. Influence of dimethyl selenide and dimethyl telluride on the limits of inflammability of hydrogen-air mixtures. Y. Tanaka and Y. Nagai. *J. Soc. Chem. Ind. Japan* (supplement), October, pp. 171-173B (in English).

INORGANIC.—The effect of hydrochloric acid on the oxidation of stannous chloride with air. S. Miyamoto. *Bull. Chem. Soc. Japan*, October, pp. 259-270 (in English).

Patent Literature

The following information is prepared from published Patent Specifications and from the Illustrated Official Journal (Patents) by permission of the Controller to H.M. Stationery Office. Printed copies of full Patent Specifications accepted may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, at 1s. each.

Abstracts of Complete Specifications

280,972. ACETIC ANHYDRIDE, MANUFACTURE OF. H. Dreyfus, 8, Waterloo Place, London, S.W.1. Application date, May 26, 1926.

Specification No. 257,968 (see THE CHEMICAL AGE, Vol. XV, p. 376) describes the production of acetic anhydride by passing acetic acid vapour over water binding agents. In this invention, the vapour is passed over a heated catalyst consisting of one or more of the phosphoric acids at a temperature of 150°–400° C. The phosphoric acid may be circulated continuously through a regeneration zone, where it is heated to remove water. The reaction gases are subjected to fractional condensation, as described in Specification No. 256,663 (see THE CHEMICAL AGE, Vol. XV, p. 278), by leading them through one or more fractionating columns maintained at temperatures between the boiling points of acetic anhydride and water.

281,016. DYESTUFFS FROM BENZANTHRONE, PRODUCTION OF. The British Alizarine Co., Ltd., W. H. Dawson, and P. Beghin, Trafford Park, Manchester. Application date, August 26, 1926.

Benanthrone and Bz1-halogenated benzantrones when treated with strong alkalis or alkali metal alcoholates or alkali metal anilides yield violanthrone or isoviolanthrone (dibenzanthrone and isodibenzanthrone), but the union of the two molecules is not complete and a substantial yield of by-products which are not dyes is obtained. In this invention, the by-products are subjected to further treatment at high temperatures with alkali, e.g., caustic potash or alkali metal alcoholates or alkali metal anilides or caustic potash and aromatic amine. A substantial further yield of violanthrone or isoviolanthrone is thus obtained. It is found that if the original fusion of the Bz1-halogenated benanthrone is effected with alcoholic potash the by-products will react more readily with aniline and potash, and vice versa. Examples are given.

281,035. RECOVERY OF SODA FROM ITS SOLUTIONS. W. M. Wallace, Randolph Hill, Denny, Stirlingshire, and J. Macgregor, of Ernest Scott and Co., Ltd., Pradfield Road, Silvertown, London, E.16. Application date, September 13, 1926.

Specification No. 217,468 (see THE CHEMICAL AGE, Vol. XI, p. 70) describes the recovery of soda from spent liquor produced in the treatment of esparto, rags, straw, grass, bamboo, etc., in which the liquor is concentrated and calcined, and discharged from the furnace on to a travelling grate to which air is supplied so that further burning takes place, and the material is then conveyed to the causticising pots. In this invention, the calcined material is conveyed first to a vessel in which it is broken up and dissolved, and then passes to a tank where insoluble material settles, and the solution then flows to the causticising pots.

281,114. DYESTUFFS, MANUFACTURE OF, AND DYEING CELLULOSE ESTERS. C. M. Barnard, 167, Market Street, Hyde, Cheshire, and The British Alizarine Co., Ltd., Trafford Park, Manchester. Application date, January 6, 1927.

Specification No. 258,960 (see THE CHEMICAL AGE, Vol. XV, p. 455) describes the preparation of dyestuffs for cellulose esters by condensing citric acid with an amino compound of amino-anthraquinone or its derivatives such as benzanthrone. In this invention, citric acid is fused with an azo-dyestuff containing one or more free primary amino groups and no sulphonic group to obtain a water soluble dyestuff. The products if the molecular weight is sufficiently low are suitable for dyeing cellulose esters. The citric acid may be fused directly with the azo-dyestuffs or with an amino derivative of a compound which can afterwards be treated to form the azo dye, e.g., with a nitro-amine which can be reduced, diazotised, and coupled with a substance such as beta-naphthol to form an azo-dyestuff. An example is given of the fusion of citric acid with para-amino-benzene azo β -naphthol to

obtain a dyestuff which gives an orange-brown shade on cellulose acetate.

281,133. PURIFYING SULPHUR CONTAINING BITUMEN, PROCESS FOR. William Blythe and Co., Ltd., Holland Bank Chemical Works, Church, Lanes., W. H. Bentley, 25, Uppingham Road, Wallasey, Cheshire, and B. Catlow, 68, Rhydding Street, Oswaldtwistle, Lanes. Application date, February 12, 1927.

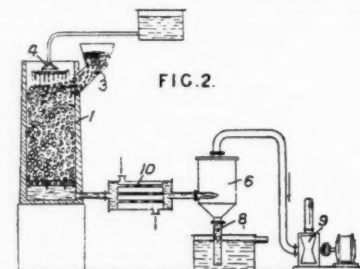
The process is for removing the bitumen from natural sulphur, or sulphur obtained from spent oxide. It has been found that the amount of bitumen can be reduced but not completely removed by distilling the sulphur, but it may be completely removed if the sulphur is distilled with a finely divided inert material which may be of an adsorbent nature. Suitable substances are finely divided calcium sulphate, calcium phosphate (bone ash), sodium sulphate, powdered charcoal, active carbon, precipitated silica, silica gel, kieselguhr, or fine sand. Examples are given of the treatment of Sicilian or American sulphur containing up to 2 per cent. of bitumen, and also spent oxide sulphur.

NOTE.—Abstracts of the following specifications, which are now accepted, appeared in THE CHEMICAL AGE when they became open to inspection under the International Convention:—269,179 (E. G. T. Gustafsson), relating to production of metals from oxide ores, see Vol. XVII, p. 7 (Metallurgical Section); 271,044 (Holzverkohlungs-Industrie Akt.-Ges.), relating to concentrating volatile aliphatic acids, see Vol. XVII, p. 62; 271,828 (Holzverkohlungs-Industrie Akt.-Ges.), relating to concentrating raw pyrolygneous acid, see Vol. XVII, p. 116; 271,881 (M. Frischer), relating to volatile inorganic acids, see Vol. XVII, p. 134; 273,659 (General Motors Corporation), relating to electrolytic deposition of chromium, see Vol. XVII, p. 23 (Metallurgical Section); 274,882 (R. Appel), relating to electrolytic separation of metallic chromium, see Vol. XVII, p. 31 (Metallurgical Section); 275,213 (Chemische Fabrik auf Actien, vorm. E. Schering), relating to iodine substituted benzonitriles with a linkage of the phenol ether type, see Vol. XVII, p. 311.

International Specifications not yet Accepted

279,037. CALCIUM NITRATE. Appareils et Evaporateurs Kestner, 5, Rue de Toul, Lille, Nord, France. International Convention date, October 16, 1926.

In an apparatus for obtaining calcium nitrate from nitric



279,037

acid and calcium carbonate, the carbonate is fed from a hopper 3 to a tower 1, and nitric acid is sprayed through a device 4. The nitrate solution and carbon dioxide are drawn by a fan 9 through a tubular heater 10 at 70°–80° C. to ensure complete reaction between the limestone particles and the acid, and then to a separator 6, from which the nitrate flows to a tank 8.

279,466. BASE EXCHANGING SUBSTANCES. Selden Co., 339, Second Avenue, Pittsburg, U.S.A. (Assignees of A. O. Jaeger, 9, Grandview Avenue, Crafton, Pa., U.S.A.) International Convention date, October 19, 1926.

These substances which may be used for water purification, gas adsorption, catalysis, or as pigments, insecticides, seed

disinfectants or cements, are obtained by the reaction of one soluble silicate, one metal salt, and at least one metallate to obtain a product alkaline to litmus. A large number of examples of the production of these substances and of their use for a wide variety of purposes are given.

- 279,488. HYDROCARBONS. D. Florentin, A. Kling, and C. Matignon, 7 bis, Rue du Louvre, Paris. International Convention date, October 23, 1926. Addition to 276,007. (See THE CHEMICAL AGE, Vol. XVII, p. 330.)

In an example of hydrogenation as applied to phenolic oils and tars, a phenolic oil from coke is treated with hydrogen and dried alumina at 450–460° C. at a pressure of 80 kilos. per sq. cm., yielding 75–80 per cent. of a mobile liquid 65 per cent. of which boils between 70° C. and 180° C., and consists mainly of benzene hydrocarbons. If low temperature tars are treated, a second catalyst may also be used, such as a halogenide of magnesium, zinc, iron, chromium, aluminium, etc., and the hydrogenation is effected in two stages.

- 279,489. DYES. I.G. Farbenindustrie Akt.-Ges., Frankfurt-on-Main, Germany. International Convention date, October 23, 1926.

A 3-methylbenzene-1-thioglycolic acid substituted in the 2-position by 'CN, 'CONH₂, or 'COOH, is treated with a ring-closing condensing agent, and the 4-methyloxy-thionaphthene is either oxidised or condensed with a diketone or a reactive derivative. In an example, 3-methylbenzene-1-thioglycolic-2-carboxylic acid nitrile is heated with caustic soda solution and the resulting 3-amino-1-thionaphthene-2-carboxylic acid converted into the oxythionaphthene by heating with dilute sulphuric acid, and oxidised to the dyestuff as usual. The above-mentioned nitrile is obtained by substituting the cyano group for the amino group in 1-methyl-2-amino-3-nitrobenzene, reducing the nitro group to the amino group and exchanging the latter for the thioglycolic acid residue by way of the diazo compound.

- 279,506. ACIDYL NAPHTHALENES AND ACENAPHTHENES. I.G. Farbenindustrie Akt.-Ges., Frankfurt-on-Main, Germany. International Convention date, October 23, 1926.

Monoacidyl derivatives of the naphthalene and acenaphthene series are treated with an aromatic or aliphatic acid chloride in the presence of aluminium chloride to obtain the diacidyl derivatives. Thus, α -benzoylnaphthalene may be heated with benzoyl chloride and aluminium chloride, and the product decomposed with water, washed with caustic soda, and crystallised from benzene. 1:5-dibenzoylnaphthalene crystallises, and 1:8-dibenzoylnaphthalene can be obtained from the mother liquor. The preparation of dibenzoylacenaphthene and diacetylacenaphthene is also described.

- 279,515. ALUMINIUM COMPOUNDS. Clay Reduction Co., 1030, West North Avenue, Chicago. (Assignees of S. S. Svendsen, Chicago.) International Convention date, October 25, 1926.

Bauxite or felspar is heated to 34°–100° C. with a solution of ammonium fluoride or bifluoride to obtain ammonium silicofluoride, ammonium titanate or vanadic fluoride, and aluminium and other fluorides. The solution is dried and heated to 400°–500° C. to volatilise silicon, vanadium, and titanium fluorides, and ammonia, and the residue is reduced and treated with ammonia and hydrochloric acid gas to convert the fluorides to chlorides. Aluminium chloride and fluoride pass off and are fractionally condensed, and the chloride may be treated with steam to obtain alumina and hydrochloric acid.

- 279,774. PURIFYING LIQUID HYDROCARBONS. Allgemeine Ges. für Chemische Industrie, 33, Unter den Linden, Berlin. International Convention date, November 1, 1926.

Mineral and tar oils are treated in a tower with an ascending current of sulphur dioxide, and the upper end of the tower is widened to reduce the velocity of the oil and facilitate separation of the entrained gas.

- 279,786. TREATING TITANIFEROUS SOLUTIONS. Titan Co. Aktieselskabet, Fredriksstad, Norway. International Convention date, October 28, 1926.

Ilmenite is treated with sulphuric acid and the solution reduced with iron. The solution contains 90–130 grms.

TiO₂ per litre and the temperature should be below 60° C. Spongy iron may be used, and the necessary amount calculated.

- 279,790. THIURAMDISULPHIDES. Silesia Verein Chemischer Fabriken, Ida-und Marienhütte, near Saarau, Germany. International Convention date, October 30, 1926.

Alkyl-aryl-substituted dithiocarbamic acids in alkaline solution are oxidised by a mixture of nitric oxide and air to obtain thiuramdisulphides. An example is given.

- 279,811–2. CYANAMIDES. N. Caro, 8, Budapesterstrasse, Berlin, and A. R. Frank, 138, Kurfürstendamm, Halensee, Berlin. International Convention date, October 27, 1926.

279,811. Calcium or magnesium carbonate or dolomite is treated at or slightly above its dissociation temperature with ammonia, in ceramic or quartz vessels, in the absence of iron, nickel, etc., to obtain the cyanamides.

279,812. Oxides, carbonates, or salts of the alkaline earth metals or magnesium are heated above 400° C. and treated with hydrocyanic acid gas to obtain cyanamides.

- 279,815. VULCANISATION ACCELERATORS. Naugatuck Chemical Co., Elm Street, Naugatuck, Conn., U.S.A. (Assignees of S. M. Cadwell, 561, West 58th Street, New York.) International Convention date, November 1, 1926.

A vulcanisation accelerator consists of a halogen-containing or other derivative of an aldehyde-amine condensation product, particularly a condensation product of an aliphatic aldehyde having 2–7 carbon atoms in the molecule, and a primary amine. Examples are given, employing the condensation product of heptaldehyde and aniline.

- 279,825. DESTRUCTIVE HYDROGENATION. I.G. Farbenindustrie Akt.-Ges., Frankfurt-on-Main, Germany. International Convention date, October 28, 1926.

Coal, tar, oils, etc., are subjected to heat treatment in iron-nickel-chromium tubes heated to 420° C. by the passage of an electric current.

Specifications Accepted, with Date of Application

- 262,738. Products arising during the liquefaction of coal by hydrogenation, Process for elaborating. Deutsche Bergin Akt.-Ges. für Kohle und Erdölchemie. December 11, 1925.
- 261,362. Distillation of carbonaceous material. L. C. Karrick. November 16, 1925.
- 267,138. Hot desulphurisation of gases derived from the distillation or the pyrogenation of solid, liquid or other combustibles, Process and apparatus for. Soc. Internationale des Procédés Prodhomme Houdry. March 4, 1926.
- 270,661. Chambers for the manufacture of sulphuric acid. M. Colombo Y Manni. May 6, 1926.
- 271,877. Roasting of zinc sulphide ores. Soc. Generale Metallurgique de Hoboken. May 27, 1926.
- 279,370. Reducing zinc ores, Process of. H. Wittek. October 23, 1926.
- 281,741. Ores of copper and other metals, Treatment of. F. Dietzsch. July 7, 1926.
- 281,763. Magnetic alloys. W. S. Smith, H. J. Garnett, and J. A. Holden. September 8, 1926.
- 281,767. Secondary disazo dyes. British Dyestuff Corporation, Ltd., J. Baddiley, P. Chorley, and R. Brightman. September 8, 1926.
- 281,769. Distilling crude oil from shale, Method of and apparatus for. C. A. Spatz. September 9, 1926.
- 281,795. New derivatives of 2:3-hydroxynaphthoic arylides, Manufacture of. British Dyestuffs Corporation, Ltd., J. B. Payman, and H. Wignall. September 20, 1926.
- 281,799. Hardening copper and copper alloys, Method of. O. W. Gustafson. September 21, 1926.
- 281,827. Aqueous solutions of acetic or formic acid, Method of concentrating. W. N. Haworth and J. Nelson, Ltd. October 19, 1926.
- 281,852. Apparatus for stirring and mixing. J. Y. Johnson. (I.G. Farbenindustrie Akt.-Ges.) November 15, 1926.
- 281,912. Aluminium alloy. H. C. Hall, and T. F. Bradbury. March 17, 1927.
- 281,927. Esters of the cellulose series, Manufacture of. O. Y. Imray. (I.G. Farbenindustrie Akt.-Ges.) April 19, 1927.
- 281,950. Alloys. T. H. Kelly. May 31, 1927.
- 281,963. Pure iron, Manufacture and production of. J. Y. Johnson. (I.G. Farbenindustrie Akt.-Ges.) June 26, 1927. Addition to 262,938.

Weekly Prices of British Chemical Products

The prices and comments given below respecting British chemical products are based on direct information supplied by the British manufacturers concerned. Unless otherwise qualified, the figures quoted apply to fair quantities, net and naked at makers' works.

General Heavy Chemicals

ACID ACETIC, 40% TECH.—£19 per ton.
 ACID BORIC, COMMERCIAL.—Crystal, £30 per ton; powder, £32 per ton; extra fine powder, £34 per ton.
 ACID HYDROCHLORIC.—3s. 9d. to 6s. per carboy d/d, according to purity strength, and locality.
 ACID NITRIC, 80° Tw.—£21 10s. to £27 per ton, makers' works, according to district and quality.
 ACID SULPHURIC.—Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations; 140° Tw., Crude Acid, 60s. per ton, 168° Tw., Arsenical, £5 10s. per ton, 168° Tw., Non-arsenical, £6 15s. per ton.
 AMMONIA ALKALI.—£6 15s. per ton f.o.r. Special terms for contracts.
 BISULPHITE OF LIME.—£7 10s. per ton, f.o.r. London, packages extra.
 BLEACHING POWDER.—Spot, £9 10s. per ton d/d; Contract, £8 10s. per ton d/d, 4-ton lots.
 BORAX, COMMERCIAL.—Crystals, £19 10s. to £20 per ton; granulated, £19 per ton; powder, £21 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
 CALCIUM CHLORIDE (SOLID).—£5 to £5 5s. per ton d/d carr. paid.
 COPPER SULPHATE.—£25 to £25 10s. per ton.
 METHYLATED SPIRIT 61 O.P.—Industrial, 2s. 2d. to 2s. 7d. per gall.; pyridinised industrial, 2s. 4d. to 2s. 6d. per gall.; mineralised, 3s. 3d. to 3s. 7d. per gall.; 64 O.P., 1d. extra in all cases; prices according to quantity as from January 1, 1928.
 NICKEL SULPHATE.—£38 per ton d/d.
 NICKEL AMMONIA SULPHATE.—£38 per ton d/d.
 POTASH CAUSTIC.—£30 to £33 per ton.
 POTASSIUM BICHROMATE.—£4½d. per lb.
 POTASSIUM CHLORATE.—3½d. per lb., ex wharf, London, in cwt. kegs.
 SALAMMONIAC.—£45 to £50 per ton d/d. Chloride of ammonia £37 to £45 per ton, carr. paid.
 SALT CAKE.—£3 15s. to £4 per ton d/d. In bulk.
 SODA CAUSTIC, SOLID.—Spot lots delivered, £15 2s. 6d. to £18 per ton, according to strength; 20s. less for contracts.
 SODA CRYSTALS.—£5 to £5 5s. per ton, ex railway depots or ports.
 SODIUM ACETATE 97/98%.—£21 per ton.
 SODIUM BICARBONATE.—£1 to 10s. per ton, carr. paid.
 SODIUM BICHROMATE.—3½d. per lb.
 SODIUM BISULPHITE POWDER, 60/62%.—£17 10s. per ton delivered for home market, 1-cwt. drums included; £15 10s. f.o.r. London.
 SODIUM CHLORATE.—2½d. per lb.
 SODIUM NITRITE, 100% BASIS.—£27 per ton d/d.
 SODIUM PHOSPHATE.—£14 per ton, f.o.b. London, casks free.
 SODIUM SULPHATE (GLAUBER SALTS).—£3 12s. 6d. per ton.
 SODIUM SULPHIDE CONC. SOLID, 60/65.—£13 5s. per ton d/d. Contract, £13. Carr. paid.
 SODIUM SULPHIDE CRYSTALS.—Spot, £8 12s. 6d. per ton d/d. Contract, £8 10s. Carr. paid.
 SODIUM SULPHITE, PEA CRYSTALS.—£14 per ton f.o.b. London, 1-cwt. kegs included.

Coal Tar Products

ACID CARBOLIC CRYSTALS.—7½d. to 7¾d. per lb. Crude 60's, 2s. 5d. per gall. prompt; lower for 1928 delivery.
 ACID CRESYLIC 99/100.—2s. 11d. to 3s. per gall. 97/99.—2s. 4d. to 2s. 5½d. per gall. Pale, 95%, 2s. 3d. to 2s. 4d. per gall. Dark, 95%, 2s. 1d. to 2s. 2d.
 ANTHRACENE.—A quality, 2½d. per unit. 40%, £5 per ton.
 ANTHRACENE OIL, STRAINED.—8d. to 8½d. per gall. Unstrained, 7½d. to 8d. per gall.
 BENZOLE.—Crude 65's, 9½d. to 9¾d. per gall., ex works in tank wagons. Standard Motor, 1s. 1½d. to 1s. 2½d. per gall., ex works in tank wagons. Pure, 1s. 5d. to 1s. 7d. per gall., ex works in tank wagons.
 TOLUOLE.—90%, 1s. 4d. to 1s. 8d. per gall. Firm. Pure, 1s. 10d. to 2s. per gall.
 XYLOL.—1s. 3d. to 1s. 10d. per gall. Pure, 1s. 9d. per gall.
 CREOSOTE.—Cresylic, 20/24%, 10d. to 11d. per gall.; middle oil, 13d. to 9d. per gall. Heavy, 8½d. to 9d. per gall. Standard specification, 7½d. to 7¾d. ex works. Salty, 7d. per gall., less 1¼%.
 NAPHTHA.—Crude, 9d. to 10d. per gall. Solvent 90/160, 9½d. to 10½d. per gall. Solvent 95/160, 1s. 3d. to 1s. 4d. per gall. Solvent 90/190, 9½d. to 1s. 3d. per gall.
 NAPHTHALENE CRUDE.—Drained Creosote Salts, £5 per ton. Whizzed or hot pressed, £8 per ton.
 NAPHTHALENE.—Crystals, £13 to £13 10s. per ton. Quiet. Flaked, £14 to £15 per ton, according to districts.
 PITCH.—Medium soft, 85s. to 90s. per ton, f.o.b., according to district. Market firm.
 PYRIDINE.—90/140, 6s. to 6s. 6d. per gall. 90/180, 3s. 6d. to 5s. per gall. Heavy, 3s. to 3s. 6d. per gall.

Intermediates and Dyes

In the following list of Intermediates delivered prices include packages except where otherwise stated:
 ACID AMIDONAPHTHOL DISULPHO (1-8-2-4).—10s. 9d. per lb.
 ACID ANTHRANILIC.—6s. per lb. 100%.
 ACID BENZOIC.—1s. 9d. per lb.
 ACID GAMMA.—4s. 6d. per lb.
 ACID H.—3s. per lb.
 ACID NAPHTHIONIC.—1s. 6d. per lb.
 ACID NEVILLE AND WINTHER.—4s. 9d. per lb.
 ACID SULPHANILIC.—8½d. per lb.
 ANILINE OIL.—8d. per lb. naked at works.
 ANILINE SALTS.—8d. per lb. naked at works.
 BENZALDEHYDE.—2s. 3d. per lb.
 BENZIDINE BASE.—3s. 3d. per lb. 100% basis d/d.
 BENZOIC ACID.—1s. 8½d. per lb.
 o-CRESOL 20/31° C.—5½d. per lb.
 m-CRESOL 98/100%.—2s. 3d. to 2s. 5d. per lb.
 p-CRESOL 32/34° C.—2s. 3d. to 2s. 5d. per lb.
 DICHLORANILINE.—1s. 10d. per lb.
 DIMETHYLANILINE.—1s. 11d. per lb.
 DINITROBENZENE.—8½d. per lb. naked at works. £75 per ton.
 DINITROCHLOROBENZENE.—£84 per ton d/d.
 DINITROTOLUENE.—48/50° C. 8d. per lb. naked at works. 66/68° C. 9d. per lb. naked at works.
 DIPHENYLAMINE.—2s. 10d. per lb. d/d.
 a-NAPHTHOL.—2s. per lb. d/d.
 B-NAPHTHOL.—10d. per lb. d/d.
 a-NAPHTHYLAMINE.—1s. 3d. per lb.
 B-NAPHTHYLAMINE.—3s. per lb.
 o-NITRANILINE.—5s. 9d. per lb.
 m-NITRANILINE.—3s. per lb. d/d.
 p-NITRANILINE.—1s. 8d. per lb.
 NITROBENZENE.—6d. per lb. naked at works.
 NITRONAPHTHALENE.—1s. 3d. per lb.
 R. SALT.—2s. 2d. per lb.
 SODIUM NAPHTHIONATE.—1s. 8½d. per lb. 100% basis d/d.
 o-TOLUIDINE.—8½d. per lb.
 p-TOLUIDINE.—2s. per lb. naked at works.
 m-XYLIDINE ACETATE.—2s. 11d. per lb. 100%.
 N. W. ACID.—4s. 9d. per lb. 100%.

Wood Distillation Products

ACETATE OF LIME.—Brown, £10 5s. per ton. Good demand.
 Grey, £14 10s. to £15 per ton. Liquor, 9d. per gall.
 CHARCOAL.—£6 to £9 per ton, according to grade and locality. Foreign competition severe.
 IRON LIQUOR.—1s. 3d. per gall, 32° Tw. 1s. per gall, 24° Tw.
 RED LIQUOR.—9d. to 10d. per gall.
 WOOD CREOSOTE.—1s. 9d. per gall. Unrefined.
 WOOD NAPHTHA, MISCIBLE.—3s. 11d. to 4s. 3d. per gall. Solvent, 4s. 3d. per gall.
 WOOD TAR.—£4 to £5 per ton.
 BROWN SUGAR OF LEAD.—£40 15s. per ton.

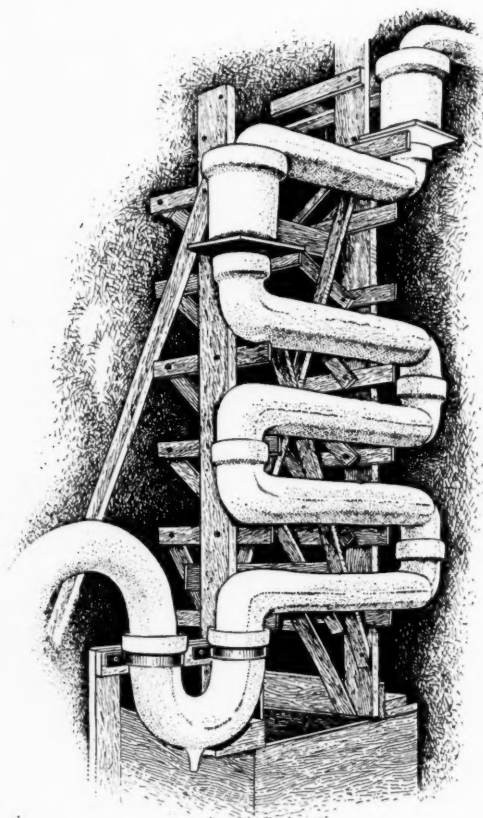
Rubber Chemicals

ANTIMONY SULPHIDE.—Golden, 6½d. to 1s. 5½d. per lb., according to quality; Crimson, 1s. 4d. to 1s. 6d. per lb., according to quality.
 ARSENIC SULPHIDE, YELLOW.—1s. 9d. per lb.
 BARYTES.—£3 10s. to £6 15s. per ton, according to quality.
 CADMIUM SULPHIDE.—2s. 6d. to 2s. 9d. per lb.
 CARBON BISULPHIDE.—£20 to £25 per ton, according to quantity.
 CARBON BLACK.—5½d. per lb., ex wharf.
 CARBON TETRACHLORIDE.—£45 to £50 per ton, according to quantity, drums extra.
 CHROMIUM OXIDE, GREEN.—1s. 1d. per lb.
 DIPHENYLGUANIDINE.—3d. 9d. per lb.
 INDIARUBBER SUBSTITUTES, WHITE AND DARK.—5½d. to 6½d. per lb.
 LAMP BLACK.—£35 per ton, barrels free.
 LEAD HYPOSULPHITE.—9d. per lb.
 LITHOPHONE, 30%.—£22 10s. per ton.
 MINERAL RUBBER "RUBPRON".—£13 12s. 6d. per ton, f.o.r. London.
 SULPHUR.—£9 to £11 per ton, according to quality.
 SULPHUR CHLORIDE.—4d. to 7d. per lb., carboys extra.
 SULPHUR PRECIP. B.P.—£47 10s. to £50 per ton.
 THIOCARBAMIDE.—2s. 6d. to 2s. 9d. per lb., carriage paid.
 THIOCARBANILIDE.—2s. 1d. to 2s. 3d. per lb.
 VERMILION, PALE OR DEEP.—6s. to 6s. 3d. per lb.
 ZINC SULPHIDE.—1s. per lb.

Pharmaceutical and Photographic Chemicals

ACID, ACETIC, PURE, 80%.—£39 per ton ex wharf London in glass containers.
 ACID, ACETYL SALICYLIC.—2s. 3½d. to 2s. 5d. per lb.

The "VITREOSIL"



COLUMN OF "VITREOSIL" ABSORPTION VESSELS.

System of HYDROCHLORIC ACID ABSORPTION

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- ACID, BENZOIC, B.P.—2s. to 3s. 3d. per lb., according to quantity. Solely ex Gum, 1s. to 1s. 3d. per oz., according to quantity.
- ACID, BORIC B.P.—Crystal, 36s. to 39s. per cwt.; powder, 40s. to 43s. per cwt.; extra fine powder, 42s. per cwt., according to quantity. Carriage paid any station in Great Britain, in ton lots.
- ACID, CAMPHORIC.—19s. to 21s. per lb.
- ACID, CITRIC.—1s. 6½d. to 1s. 7d. per lb., less 5%.
- ACID, GALLIC.—2s. 8d. per lb. for pure crystal, in cwt. lots.
- ACID, PYROGALLIC, CRYSTALS.—7s. 3d. per lb. Resublimed, 8s. 3d. per lb.
- ACID, SALICYLIC, B.P. PULV.—1s. 2½d. to 1s. 3½d. per lb.; Technical.—1½d. to 1½d. per lb.
- ACID, TANNIC B.P.—2s. 8d. to 2s. 10d. per lb.
- ACID, TARTARIC.—1s. 3½d. per lb., less 5%.
- ACETANILIDE.—1s. 6d. to 1s. 9d. per lb. for quantities.
- AMIDOL.—7s. 6d. to 9s. per lb., d/d.
- AMIDOPYRIN.—8s. to 8s. 3d. per lb.
- AMMONIUM BENZOATE.—3s. 3d. to 3s. 6d. per lb., according to quantity.
- AMMONIUM CARBONATE B.P.—£37 per ton. Powder, £39 per ton in 5 cwt. casks. Resublimed, 1s. per lb.
- ATROPINE SULPHATE.—9s. per oz.
- BARBITONE.—5s. 9d. to 6s. per lb.
- BENZONAPHTHOL.—3s. 3d. per lb. spot.
- BISMUTH CARBONATE.—10s. 4d. to 10s. 7d. per lb.
- BISMUTH CITRATE.—9s. 10d. to 10s. 1d. per lb.
- BISMUTH SALICYLATE.—8s. 10d. to 10s. 1d. per lb.
- BISMUTH SUBNITRATE.—8s. 4d. to 8s. 7d. per lb.
- BISMUTH NITRATE.—6s. 1d. to 6s. 4d. per lb.
- BISMUTH OXIDE.—13s. 10d. to 14s. 1d. per lb.
- BISMUTH SUBCHLORIDE.—13s. 10d. to 14s. 1d. per lb.
- BISMUTH SUBGALLATE.—8s. 1d. to 8s. 4d. per lb. Extra and reduced prices for smaller and larger quantities respectively; Liquor Bismuthi et Ammon. Cit. B.P. in W. Qts. 1s. 1d. per lb.; 12 W. Qts. 1s. per lb.; 36 W. Qts., 1½d. per lb.
- BORAX B.P.—Crystal, 25s. per cwt.; powder, 26s. per cwt., according to quantity. Carriage paid any station in Great Britain, in ton lots.
- BROMIDES.—Ammonium, 1s. 11d. to 2s. 1d. per lb.; potassium, 1s. 7½d. to 1s. 9½d. per lb.; sodium, 1s. 10d. to 2s. per lb.; granulated, ½d. per lb. less; all spot. Large quantities at lower rates.
- CALCIUM LACTATE.—1s. 2½d. to 1s. 3½d. per lb.
- CAMPHOR.—Refined flowers, 2s. 11d. to 3s. 1d. per lb., according to quantity; also special contract prices.
- CHLORAL HYDRATE.—3s. 2d. to 3s. 4d. per lb.
- CHLOROFORM.—2s. 3d. to 2s. 7½d. per lb., according to quantity.
- CREOSOTE CARBONATE.—6s. per lb.
- ETHERS.—S.G. 730.—1s. 1½d. to 10½d., drums; other gravities at proportionate prices.
- FORMALDEHYDE.—£39 per ton, in barrels ex wharf.
- GUAIACOL CARBONATE.—4s. 9d. to 5s. per lb.
- HEXAMINE.—2s. 3d. to 2s. 6d. per lb.
- HOMATROPINE HYDROBROMIDE.—30s. per oz.
- HYDRASTINE HYDROCHLORIDE.—English make offered at 120s. per oz.
- HYDROGEN PEROXIDE (12 VOLS.).—1s. 4d. per gallon, f.o.r. makers' works, naked. Winchesters, 2s. 11d. per gall. B.P., 10 vols., 2s. to 2s. 3d. per gall.; 20 vols., 3s. to 4s. per gall.
- HYDROQUINONE.—3s. 10d. per lb., in cwt. lots.
- HYPOPHOSPHITES.—Calcium, 3s. 6d. per lb., for 28-lb. lots; potassium, 4s. 1d. per lb.; sodium, 4s. per lb.
- IRON AMMONIUM CITRATE.—B.P., 2s. 1d. to 2s. 4d. per lb. Green, 2s. 4d. to 2s. 9d. per lb.; U.S.P., 2s. 2d. to 2s. 5d. per lb.
- IRON PERCHLORIDE.—18s. to 20s. per cwt., according to quantity.
- MAGNESIUM CARBONATE.—Light commercial, £31 per ton net.
- MAGNESIUM OXIDE.—Light commercial, £62 10s. per ton, less 2½%; Heavy commercial, £21 per ton, less 2½%; in quantity lower; Heavy Pure, 2s. to 2s. 3d. per lb., in 1 cwt. lots.
- MENTHOL.—A.B.R. recrystallised B.P., 15s. 6d. per lb. net for January delivery; Synthetic detached crystals, 9s. to 12s. 6d. per lb., according to quantity; Liquid (95%), 11s. 3d. per lb.
- MERCURIALS B.P.—Up to 1 cwt. lots, Red Oxide, 7s. 6d. to 7s. 7d. per lb., levig., 7s. to 7s. 1d. per lb.; Corrosive Sublimate, Lump, 5s. 9d. to 5s. 10d. per lb., Powder, 5s. 2d. to 5s. 3d. per lb.; White Precipitate, Lump, 5s. 11d. to 6s. per lb., Powder, 6s. to 6s. 1d. per lb., Extra Fine, 6s. 1d. to 6s. 2d. per lb.; Calomel, 6s. 4d. to 6s. 5d. per lb.; Yellow Oxide, 6s. 10d. to 6s. 11d. per lb.; Persulph., B.P.C., 6s. 1d. to 6s. 2d. per lb.; Sulph. nig., 5s. 10s. to 5s. 11d. per lb. Special prices for larger quantities.
- METHYL SALICYLATE.—1s. 5d. to 1s. 7d. per lb.
- METHYL SULPHONAL.—9s. to 9s. 3d. per lb.
- METOL.—9s. to 11s. 6d. per lb. British make.
- PARA-FORMALDEHYDE.—1s. 9d. per lb. for 100% powder.
- PARALDEHYDE.—1s. 1d. to 1s. 4d. per lb.
- PHENACETIN.—2s. 6d. to 2s. 9d. per lb.
- PHENAZONE.—4s. to 4s. 3d. per lb.
- PHENOLPHTHALEIN.—6s. 6d. to 6s. 9d. per lb.
- POTASSIUM BITARTRATE 99/100% (Cream of Tartar).—96s. per cwt., less 2½ per cent.
- POTASSIUM CITRATE.—B.P.C., 1911, 1s. 8d. to 1s. 11d. per lb.; U.S.P., 1s. 11d. to 2s. 2d. per lb.
- POTASSIUM FERRICYANIDE.—1s. 9d. per lb., in cwt. lots.
- POTASSIUM IODIDE.—16s. 8d. to 17s. 2d. per lb., according to quantity.
- POTASSIUM METABISULPHITE.—6d. per lb., 1-cwt. kegs included, f.o.r. London.
- POTASSIUM PERMANGANATE.—B.P. crystals, 5½d. per lb., spot.
- QUININE SULPHATE.—1s. 8d. to 1s. 9d. per oz., bulk in 100 oz. tins.
- RESORCIN.—2s. 10d. to 3s. per lb., spot.
- SACCHARIN.—55s. per lb.; in quantity lower.
- SALOL.—2s. 4d. per lb.
- SODIUM BENZOATE, B.P.—1s. 8d. to 1s. 11d. per lb.
- SODIUM CITRATE, B.P.C., 1911.—1s. 8d. to 1s. 11d. per lb., B.P.C., 1923—2s. to 2s. 1d. per lb. for 1-cwt. lots. U.S.P., 1s. 11d. to 2s. 2d. per lb., according to quantity.
- SODIUM FERROCYANIDE.—4d. per lb., carriage paid.
- SODIUM HYPOSULPHITE, PHOTOGRAPHIC.—£15 5s. per ton, d/d consignee's station in 1-cwt. kegs.
- SODIUM NITROPRUSSIDE.—16s. per lb.
- SODIUM POTASSIUM TARTRATE (ROCHELLE SALT).—90s. to 95s. per cwt. Crystals, 5s. per cwt. extra.
- SODIUM SALICYLATE.—Powder, 1s. 7d. to 1s. 9d. per lb. Crystal, 1s. 8d. to 1s. 10d. per lb.
- SODIUM SULPHIDE, PURE RECRYSTALLISED.—10d. to 1s. 1d. per lb.
- SODIUM SULPHITE, ANHYDROUS.—£27 10s. to £28 10s. per ton, according to quantity. Delivered U.K.
- SULPHONAL.—6s. 9d. to 7s. per lb.
- TARTAR Emetic, B.P.—Crystal or powder, 2s. 1d. to 2s. 3d. per lb.
- THYMOL.—Puriss., 10s. to 10s. 3d. per lb., according to quantity. Firmer. Natural, 14s. 3d. per lb.

Perfumery Chemicals

- ACETOPHENONE.—7s. per lb.
- AUBEPINE (EX ANETHOL).—11s. per lb.
- AMYL ACETATE.—2s. per lb.
- AMYL BUTYRATE.—5s. 3d. per lb.
- AMYL SALICYLATE.—3s. per lb.
- ANETHOL (M.P. 21/22° C.).—5s. 6d. per lb.
- BENZYL ACETATE FROM CHLORINE-FREE BENZYL ALCOHOL.—2s. per lb.
- BENZYL ALCOHOL FREE FROM CHLORINE.—2s. per lb.
- BENZALDEHYDE FREE FROM CHLORINE.—2s. 6d. per lb.
- BENZYL BENZOATE.—2s. 6d. per lb.
- CINNAMIC ALDEHYDE NATURAL.—10s. 6d. per lb.
- COUMARIN.—10s. per lb.
- CITRONELLOL.—13s. 3d. per lb.
- CITRAL.—8s. 3d. per lb.
- ETHYL CINNAMATE.—6s. per lb.
- ETHYL PETHALATE.—3s. per lb.
- EUGENOL.—8s. 3d. per lb.
- GERANIOL (PALMAROSA).—17s. 9d. per lb.
- GERANIOL.—6s. to 10s. per lb.
- HELIOTROPINE.—4s. 9d. per lb.
- ISO EUGENOL.—13s. per lb.
- LINALOOL.—Ex Bois de Rose, 14s. per lb. Ex Shui Oil, 9s. 9d. per lb.
- LINALYL ACETATE.—Ex Bois de Rose, 17s. 6d. per lb. Ex Shui Oil, 13s. 9d. per lb.
- METHYL ANTHRANILATE.—8s. 6d. per lb.
- METHYL BENZOATE.—4s. per lb.
- MUSK KETONE.—35s. per lb.
- MUSK XYLOL.—8s. per lb.
- NEROLIN.—4s. 6d. per lb.
- PHENYL ETHYL ACETATE.—12s. per lb.
- PHENYL ETHYL ALCOHOL.—10s. 6d. per lb.
- RHODINOL.—31s. 6d. per lb.
- SAFROL.—1s. 6d. per lb.
- TERPINEOL.—1s. 8d. per lb.
- VANILLIN.—15s. 3d. to 16s. 6d. per lb.

Essential Oils

- ALMOND OIL.—Foreign S.P.A., 11s. per lb.
- ANISE OIL.—2s. 9d. per lb.
- BERGAMOT OIL.—26s. per lb.
- BOURBON GERANIUM OIL.—13s. per lb.
- CAMPHOR OIL.—9d. per lb.
- CANANGA OIL, JAVA.—15s. 9d. per lb.
- CINNAMON OIL LEAF.—6d. per oz.
- CASSIA OIL, 80/85%.—7s. 3d. per lb.
- CITRONELLA OIL.—Java, 1s. 9d. per lb., c.i.f. U.K. port for shipment over 1928. Ceylon, pure, 1s. 7d. per lb.
- CLOVE OIL.—5s. per lb.
- EUCALYPTUS OIL, AUSTRALIAN.—2s. 1d. per lb.
- LAVENDER OIL.—Mont Blanc, 38/40%, Esters, 17s. per lb.
- LEMON OIL.—8s. 6d. per lb.
- LEMONGRASS OIL.—4s. 6d. per lb.
- ORANGE OIL, SWEET.—11s. 3d. per lb.
- OTTO OF ROSE OIL.—Anatolian, 35s. per oz. Bulgarian, 75s. per oz.
- PALMA ROSA OIL.—10s. 3d. per lb.
- PEPPERMINT OIL.—Wayne County, 15s. 9d. per lb.; Japanese, 8s. per lb.
- PETITGRAIN OIL.—7s. 9d. per lb.
- SANDALWOOD OIL.—Mysore, 26s. 6d. per lb.; 90/95%, 16s. 6d. per lb.

Clean and Uniform Rosin

—costing pounds
per ton less



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Imperial Chemical Industries

Acquisition of Four More Companies

At an extraordinary general meeting of the holders of the 7 per cent. cumulative preference shares of Imperial Chemical Industries, Ltd., held in London on Thursday, a resolution was unanimously passed on the motion of the chairman (Sir Alfred Mond), seconded by Sir Josiah Stamp, authorising the directors "to issue at such time or times and in such blocks as they may think expedient not exceeding £6,580,000 of the unissued capital of the company as 7 per cent. Cumulative Preference Shares each of £1, such shares to rank in all respects *pari passu* with the 7 per cent. Cumulative Preference Shares of the company existing at the time of the respective issues."

The Chairman explained that the object of this resolution was to enable the company to acquire from time to time comparatively small businesses that seemed suitable for the purpose, and it was proposed to apply £270,000 of the new capital to the acquisition of four companies—Cassel Cyanide Co., Ltd., the Union Acid Co., Oliver Wilkins and Co., and Casebourne and Co. (1926), Ltd. In reply to questions he stated that if the acquisition of these companies by the exchange of preference shares had any effect at all on the existing preference shares, it should be a beneficial effect.

On the motion of Dr. Cullen, seconded by Mr. F. E. Hamer, a vote of thanks to the Chairman, with good wishes for the New Year, was cordially passed. In acknowledging this, Sir Alfred Mond stated that they had nearly completed the first year of the new company, and the board had every reason to be satisfied with the results so far obtained.

Annual Meeting of Sulphide Corporation

THE thirty-first annual general meeting of the Sulphide Corporation, Ltd., was held in London on Friday, December 23, the Earl of Kintore presiding. Dealing with the accounts, he said that the working profit had fallen from £263,774 earned in the previous year, to £140,345, the reduction being due to a greatly reduced profit from Broken Hill, owing to the fall in metals, and a lower profit from Seaton Carew owing to the coal strike, whereas the profit from Cockle Creek showed a substantial increase. The net profit amounted to £76,484. At Cockle Creek, where they manufactured sulphuric acid, superphosphates, and cement, all departments had shown an increased production. The third contact acid plant was put into commission last May, and they were now proceeding with the construction of a fourth plant. At the English works at Seaton Carew, production had suffered from the coal strike, but since the resumption of work in December last, it had been continually maintained on a considerably increased scale. The existing contract with the Board of Trade under which the Seaton works received supplies of zinc concentrates on satisfactory terms, would terminate on June 30, 1930, and with this in mind they had been interesting themselves in the development of a large lead and zinc property in Wales, belonging to the Nantymwyn Mine, Ltd. Net profit this year was less by £115,550 than last year, and the directors were therefore only able to recommend the payment of 7½ per cent. on the preference shares.

Sixth Ramsay Chemical Dinner

THE sixth Ramsay Chemical Dinner, which was held on December 21 in the Trades Hall, Glasgow, was associated with the jubilee of the Institute of Chemistry, and was presided over by Professor Arthur Smithells, president of the Institute. The dinner was held under the auspices of the West of Scotland Sections of the Society of Chemical Industry, the Institute of Chemistry, the Society of Dyers and Colourists, the Glasgow University Alchemists' Club, the Andersonian Chemical Society, and the Ardeer Chemical Club. Among the apologies for absence received was one from Dr. R. R. Tatlock, who wrote that he was unable to be present as he was 90 years of age and at present an invalid. Nothing, he added, would have been more gratifying to him than to assist at that interesting function, as the late Sir William Ramsay was a practical chemistry pupil of his 56 years ago in Glasgow. The toast of "The Profession" was proposed by Mr. J. Craig. Mr. S. H. B. Langlands proposed the toast of "The Guests," and Professor E. C. C. Baly responded.

Latest Oil Prices

LONDON, December 28.—LINSEED OIL dull and 2s. 6d. to 7s. 6d. per ton lower. Spot, ex mill, £28; December, £26 17s. 6d.; January-April, £27; and May-August, £28. RAPE OIL steady. Crude, extracted, £44; technical, refined, £46, naked, ex wharf. COTTON OIL firm. Refined common edible, £42; Egyptian, crude, £37 10s.; and deodorised, £44 per ton. TURPENTINE inactive and unchanged. American, spot, 30s.; and January-April, 40s. per cwt. HULL, December 28.—LINSEED OIL.—Spot to April, £28 2s. 6d.; May-August, £28 7s. 6d. per ton, naked. COTTON OIL.—Bombay, crude, £31 5s.; Egyptian, black (new), £36; edible, refined, £40; technical, £36; deodorised, £42 per ton, naked. PALM KERNEL OIL.—Crushed, 5½ per cent., £30 10s. per ton, naked. GROUNDNUT OIL.—Crushed-extracted, £46 10s.; deodorised, £50 10s. per ton. SOYA OIL.—Extracted and crushed, £34; deodorised, £37 10s. per ton. RAPE OIL.—Crude-extracted, £42; refined, £44 per ton. TURPENTINE.—Spot, 41s. per cwt., net cash terms, ex mill. CASTOR OIL and COD OIL unaltered.

Nitrogen Products

Export.—The market for sulphate of ammonia continues firm, prices ranging from £9 12s. per ton to £9 16s. per ton, f.o.b. U.K. port in single bags. Most of the inquiries received are for prompt shipment. Up to the present we have not received any indication of price for forward positions, but understand that the few sales made are based on prices similar to those of the present season.

Home.—The home demand continues featureless. Routine business is being transacted at scale price but the tonnage involved is negligible. It is not expected that this market will liven until February.

Nitrate of Soda.—The market continues steady at 17s. to 17s. 3d. per metric quintal, f.a.s. Chile. There is little interest in forward positions, but on account of the large increase in production it is anticipated that a further drop in the price scale will be necessary after June next.

South Wales By-Products

South Wales by-product activities during the past week have been practically at a standstill. Requirements of the moment are small owing to the holidays, and no forward buying has been done. There is no change in prices. Pitch, which has only a small demand, sells at from 77s. 6d. to 82s. 6d. per ton. Crude naphthalene ranges from £4 10s. to £5 per ton, while solvent naphtha is unchanged at from 10d. to 1s. 0½d. per gallon, f.o.r. maker's works. Crude tar continues to sell at from 60s. to 65s. per ton; coke oven tar at 8½d. to 9d. per gallon, and gasworks tar at 7d. to 7½d. per gallon, f.o.r. maker's works, and 10d. to 1s. per gallon delivered in barrels. Patent fuel and coke (export) are unchanged, patent fuel ranging from 22s. 6d. to 24s. per ton, and coke at from 27s. 6d. to 37s. 6d. per ton.

Methylated Spirit Prices

THE Methylating Co., Ltd., announces that on and from January 1, 1928, their prices per gallon until further notice, without engagement on their part, will be as follows:—

Industrial methylated spirits, 61 o.p., 500 gallons, 2s. 2d.; 100-500 gallons, 2s. 3d.; 30-100 gallons, 2s. 5d.; 10-30 gallons, 2s. 7d.; 64 o.p. (quantities as above), 2s. 3d., 2s. 4d., 2s. 6d., 2s. 8d.; pyridinised industrial methylated spirits, 61 o.p. (quantities as above), 2s. 4d., 2s. 5d., 2s. 7d., 2s. 9d.; 64 o.p. (quantities as above), 2s. 5d., 2s. 6d., 2s. 8d., 2s. 10d.; mineralised methylated spirits (coloured violet), 61 o.p., 100-500 gallons, 3s. 3d., 30-100 gallons, 3s. 5d., 10-30 gallons, 3s. 7d.; 64 o.p., 100-500 gallons, 3s. 4d., 30-100 gallons, 3s. 6d., 10-30 gallons, 3s. 8d. Methylated resin finish is 2d. per gallon extra, and methylated shellac finish 8d. per gallon extra, over the prices quoted for pyridinised industrial methylated spirits.

Chemicals and Key Industry Duties

REPRESENTATIONS have been made to the Board of Trade under section 10 (5) of the Finance Act, 1926, with a view to exempting metaldehyde from the duty imposed by section 1 of the Safeguarding of Industries Act, 1921, as amended by the former Act. Any person desiring to communicate with the Board of Trade with respect to the application for exemption should do so by letter addressed to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, S.W.1, before January 23, 1928.

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B.P. 134° C.

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Fl. Pt. 105°F.

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- rate of evaporation intermediate between those of Ethyl Lactate and Butyl Propionate.
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- shows greater tolerance for inert diluents such as Toluene, than other nitro-cellulose solvents.
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Company News

BRITISH DRUG HOUSES, LTD.—The usual quarterly dividend of 1½ per cent. on the preference shares is payable on December 31.

ONVERWACHT PLATINUM CO.—An interim dividend (No. 3) of 5 per cent. (6d. per 10s. share) has been declared by the board for the period ending December 31, 1927, payable to shareholders registered at the close of business on that date.

LAUTARO NITRATE CO.—A final dividend out of the profits for the year ending December 31, 1927, of 3 per cent., or 3s. per share, less income tax, has been declared, payable on January 23, 1928, to shareholders on the register on December 31, 1927, and to holders of share warrant to bearer Coupon No. 62. As no interim was paid, the dividend now announced represents the total distribution for 1927. For 1926 there was no final payment, an interim (Coupon No. 61) of 5 per cent., or 5s. per share, was paid in March, 1926.

NIGERIAN BASE METALS CORPORATION.—The report for the period July 1, 1924, to December 31, 1926, states that the accounts now presented give effect to writing down of assets and subsequent acquisition of additional properties, the principal being those taken over from Niger Co. The result of the period from July 1 to December 2, 1924, the date of reorganisation of capital, was a profit of £265, which was appropriated in reduction of the sum at debit of profit and loss account. The profit and loss account now presented shows actual profit for period December 3, 1924, to December 31, 1926, was £28,700. It is the intention to make up the next accounts to March 31, 1928, and to same date in future years, so that general meetings may be held about July.

NOVOCRETE AND CEMENT PRODUCTS CO.—The profit and loss account for the year ended June 30, 1927, shows an adverse balance of £35,774. The report states that in October, 1926, the factory at Park Royal was completed and manufacture started. Although sales have increased, it has taken longer than expected to work sales up to a level on which receipts would balance outgoings. Economies have been effected by closing the London office, and transferring the staff, greatly reduced, to the works at Park Royal. Buckingham Gate premises were sold at a profit. Factory of Northern Area Co. at Ellesmere Port, which was shut down in the coal strike in 1926, has not been reopened, but stocks on hand there are being gradually sold off by Ship Canal Portland Cement Co. The directors deem it advisable to ask shareholders for authority to issue debentures up to £20,000 as and when required.

Dispute Over Trade Names

THE Liverpool Borax Company, manufacturers of an elastic roofing compound called Rito, sought an injunction in Liverpool Chancery Court recently to restrain Cartwrights, Ltd., varnish and colour manufacturers, Oldham, from using and advertising the name of Tito for a roofing compound of their own manufacture. The case was settled between the parties. Mr. Harold Mather, for the Liverpool Borax Co., explained that Cartwrights had advertised their material in an advertisement design similar to that used by the company for their Rito, which was a registered trade mark. Cartwrights had now agreed to give a perpetual undertaking to discontinue the title of Tito and to pay the Liverpool Borax Co.'s costs of the action. This was acceptable to his clients. Mr. Walmsley, for Cartwrights, concurred. He said that although there was some similarity of name it was a sheer coincidence. There was no similarity of make up in article. As soon as Cartwrights found that the other company had a similar name they at once stopped their advertisements and dropped the name of Tito and would not use it again. In addition, Cartwrights agreed to pay the costs of the action.

Mr. R. Mond Joins I.C.I. Research Council

MR. ROBERT MOND has been appointed a member of the research council of Imperial Chemical Industries, Ltd. Mr. Mond has carried out notable research in pure and applied chemistry and has given particular attention to electrolytic problems. He was associated with his father, Dr. Ludwig Mond, in researches on the metallic carbonyls and the action of nitric oxide upon them. He is honorary secretary of the Davy-Faraday Laboratory of the Royal Institution and honorary treasurer of the Faraday Society.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

County Court Judgment

[NOTE.—The publication of extracts from the "Registry of County Court Judgments" does not imply inability to pay on the part of the persons named. Many of the judgments may have been settled between the parties or paid. Registered judgments are not necessarily for debts. They may be for damages or otherwise, and the result of bona-fide contested actions. But the Registry makes no distinction of the cases. Judgments are not returned to the Registry if satisfied in the Court books within twenty-one days. When a debtor has made arrangements with his creditors we do not report subsequent County Court judgments against him.]

DARE (F.) MORDLE AND CO., LTD., Springfield Works, Basford, starch manufacturers. (C.C., 31/12/27.) £10 11s. 4d. November 9.

Receivership

GODDON AND CO., LTD. J. W. Dodds, of 26, Church Road, Richmond, ceased to act as receiver or manager on July 7, 1927. (Notice filed, December 14.)

Mortgages and Charges

[NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]

BILLING (CHARLES) AND CO., LTD., London, W.C., soap manufacturers. (M., 31/12/27.) Registered December 15, £500 debenture to A. J. Bennett, Kirklington Hall, Southwell, M.P.; general charge.

VICTORIA OIL AND REFINING CO., LTD., London, N.W. (M., 31/12/27.) Registered December 15, £2,100 charge, to Gaskell, Ltd., 49, Old Bond Street, W.; charged on tank and contents on co.'s premises at Strood. *Nil. December 8, 1926.

London Gazette, &c.

Partnership Dissolved

WM. A. SHETLIFF AND CO. (Henry STOAKES and William Alfred SHETLIFF), dry colour and chemical merchants, warehousemen and manufacturers, Lion Mills, Wincolmlee, Kingston-upon-Hull, by mutual consent as from December 1, 1927. Debts received and paid by H. Stoakes, who will continue the business.

New Companies Registered

BOTOLPH MANUFACTURING AND TRADING CO., LTD. Registered December 22. Nom. capital, £500 in £1 shares. Manufacturers of and dealers in all kinds of minerals, metals, produce, chemicals, oils, colours, paints, pigments, varnishes, polishes, etc. Directors: G. S. Crick, 85, St. James's Avenue, Beckenham, Kent, and F. O. Crick.

MACLAURIN FUEL OIL AND GAS CO., LTD., 150, Hope Street, Glasgow. Registered in Edinburgh December 22. Nom. capital, £10,000 in £1 shares (5,000 preference and 5,000 ordinary). To carry on the business of carbonising or gasifying coal or other carbonaceous material, etc. Directors: J. P. Allan, F. T. F. Carr, R. MacLaurin, G. W. Wight.

NATIONAL CHEMICAL HOLDINGS, LTD. Particulars were filed on December 15, pursuant to Section 274 of the Companies (Consolidation) Act. The capital is £250,000 in £1 shares. The company was incorporated in Guernsey on November 19, 1927, to carry on the business of chemists, druggists, drysalts, perfumiers, oil and colour men, etc. The British address is at Appleby House, 46, St. James's Place, S.W.1, where H. B. Randolph is authorised to accept service of process and notices on behalf of the company. Directors: The Right Hon. the Earl of Westmorland, H. B. Randolph, P. A. Slcombe, G. M. Williams. The articles of association state that one of the first directors shall be Lady Victor Paget.

The China Clay Trade Review

The Official Organ of the China Clay Industry and the only Journal specially devoted to its interests. Published in the third issue of "The Chemical Age" each month.

All Editorial communications should be addressed to the Editor, "The China Clay Trade Review," Benn Brothers, Ltd., Bouverie House, 154, Fleet Street, E.C.4. All communications relating to Advertisements, Subscriptions, etc., should be sent to the Manager, "The China Clay Trade Review," at this address. Telegrams—"Allangas, Fleet, London." Telephone—City 0244 (10 lines).

China Clay—The Home and Foreign Position

The question of some working arrangement as to supplies and prices has often been considered so far as home production of China Clay is concerned, but up to now no serious consideration has been given to the possibilities of such arrangements between home and foreign producers of the commodity.

Since 1914 the production of China Clays in other countries, especially in the United States of America, has grown to such an extent that Cornwall and Devon cannot be said to be in an unassailable position. The tendency of foreign countries, other than those where the principle of free trade is firmly rooted, is to impose tariffs on the imported article, in order artificially to bolster up their home industry, with the products of which the imported article is in competition. The effect of this, and it applies in the case of China Clay, is to increase the cost of the raw material to the consumer.

Tariffs No Solution

Whether the manufacturer uses home or foreign produced China Clays, he is obtaining a raw material at a very low price, oftentimes at the expense of the workers employed in the industry and of shareholders who have invested their money in it. The effect of tariffs is of no benefit to the user of China Clays, and is of doubtful advantage to the producers for whose benefit it is ostensibly imposed, the only party deriving any direct benefit therefrom being the State that imposes the tariffs. The question has recently been raised as to whether it would not be possible for all producers of China Clays, both British and foreign, to get together and discuss the possibility of so managing the production of China Clay as to insure for those engaged in it the maximum of benefit and in so doing to avoid the artificial means now adopted by foreign countries whose manufacturers use and require large quantities of China Clay at a low price.

English and Foreign Production Compared

In considering this aspect of the question the following facts relating to the present position of the production of China Clay in this and other countries is worthy of attention. The volume of English China Clay trade has to-day apparently not exceeded that attained when less capital was employed. On the other hand, the volume of China Clay production and use in U.S.A. and Europe has increased very considerably over the same period, this being particularly the case in U.S.A. European countries have increased their production and use of China Clays somewhat, although Russia to-day is practically out of the market. In the United States of America the quantity of English China Clays used has not greatly varied, but for some years the U.S.A. domestic clays have largely increased in production and consumption.

Big Increase in Demand

The natural deduction is that manufactured articles in which China Clay is used have increased and extended. As in coal, so in China Clay, there are a great many qualities, and the difference between the common and the best is

such that they may not be recognised as coming under the one generic heading "China Clay." Not only do the colour and fineness differ greatly, but frequently retention and actual working properties bear little if any relation one to the other. Colour and fineness may be improved by certain processes which call for expense and very careful handling, but retention and working properties are a gift from nature which is well known to the actual paper maker and potter among others.

Varying Qualities of Clay

The areas of commoner China Clays are extensive in many parts of the world, and capital has been invested, and much of it lost, in developing these deposits. For the time a larger production is offered than the markets call for, and the consequent low prices tend toward an unremunerative effort.

The higher qualities of China Clays are limited in their known areas. The qualities which have the retention and working properties already referred to are being worked surely if slowly to depletion in the pits from which they are produced, and the quantities obtainable are below requirements. A free and unfettered market gives the user and consumer every opportunity of obtaining the best raw materials at the lowest price. Tariffs and restrictions work in vicious circles which, once initiated, have to be adopted and extended for self-protection.

Inadequate Return on Capital

It may be admitted that the China Clay industry throughout the world does not show an adequate return upon capital employed, or wages sufficiently high to give the employee a reasonable standard of living. The remedy perhaps lies in world co-operation rather than antagonism created by tariffs and other restrictions. The user and consumer should be given an unfettered choice of the product that suits his requirements, but let him pay a reasonable price which gives a living to the industry upon which he is dependent for raw materials.

Arrangements for conferences between producers of China Clay in Europe and the United States of America should not be attended with any great difficulty in these days of quick transit and communication. Numerically those engaged in the control of the industry are not large. Trade which in the past was confined to national boundaries is to-day international, and extends more and more in this direction as the international spirit for peace increases among nations.

Merchandise Marks Act, 1926: Pottery

The Board of Trade have referred to the standing committee, appointed by them under the Act, an application for Orders in Council to be made requiring indications of origin to be given in the case of imported pottery. Representatives of any interests substantially affected who desire to be heard in opposition at the public inquiry, which will be held later by the committee, are requested to communicate with the secretary, Mr. E. W. Reardon, at the New Public Offices, Great George Street, London, S.W.1, with the least possible delay, and, if practicable, not later than July 29.

The Analysis of High Alumina Clays and Refractories.—(I).

By W. Singleton

AMONG the principal alumina-bearing materials are the minerals kaolin, feldspar, and lepidolite. Kaolin is formed from the decomposition of felspathic rocks, and, when pure, has the composition $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$, corresponding to 39.5 per cent. of alumina, 46.6 per cent. of silica, and 13.9 per cent. of water, which is completely expelled at 600° C. Kaolin, as ordinarily used, contains a number of impurities, principally oxides of iron, lime, magnesia, and alkalis.

Several species are included in the feldspar group of minerals, all of which are silicates of alumina, with one or more of the bases soda, potash, and lime. For convenience they may be divided into two groups, namely, the potash-soda feldspars and the soda-lime feldspars. The chief representatives of the potash-soda group are orthoclase and microcline, which are expressed by the formula $\text{K}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2$. The potash may partly or wholly be replaced by soda. The theoretical composition of these minerals is 64.7 per cent. of silica, 18.4 per cent. of alumina, and 16.9 per cent. of potash.

The soda-lime feldspars, or plagioclases, represent a series of minerals ranging from soda feldspar, albite, through soda-lime feldspars to limespar, anorthite. Albite is expressed by the formula $\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2$, and contains 11.8 per cent. of soda, 19.5 per cent. of alumina, and 68.7 per cent. of silica, whilst anorthite is expressed by the formula $\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$, and contains 20.1 per cent. of lime, 36.7 per cent. of alumina, and 43.2 per cent. of silica.

Methods of Fusion

Ordinary clays may be completely decomposed by fusion with sodium carbonate, but for diaspor and similar materials either sodium or potassium bisulphate must be used. It is necessary to ignite the raw materials first in order to drive off combined water. The loss on ignition is best determined on 1 g. of the material which has previously been dried at 100° to 110° C. for about one hour, and cooled in a desiccator. The sample may then be weighed into a platinum crucible, and ignited for half an hour at not less than 1000° C., care being taken to reach that temperature in gradual stages. The "loss on ignition" gives frequently variable results in the hands of different chemists, which may be accounted for chiefly by differences in the temperature of ignition.

Ganister, silica brick, and fireclays are all decomposed by fusion with sodium carbonate. The melt is allowed to cool and treated with dilute hydrochloric acid, and gently heated until all, with the exception of the silica, is in solution. The sample upon which the ignition loss has been determined is used for the analysis, after being first ground finely in an agate mortar. With materials decomposed by fusion with sodium carbonate, an excess of sodium carbonate of about 10 times the weight of the sample taken is required, but with fusions necessitating the use of sodium or potassium bisulphate an excess of about 20 times the original weight of the sample taken is necessary. The fusion in either case is carried out on, approximately, 0.5 g. of the sample, as larger quantities considerably increase the difficulty of handling the large voluminous precipitate of alumina. Fusion for half an hour with sodium carbonate is usually sufficient for ordinary clays, but materials requiring potassium bisulphate may require as long as three hours. The fusion should be commenced with a low flame, the temperature being gradually increased, until the sample is completely decomposed, which is indicated by the appearance of flocculent silica in the melt. The melt is finally dissolved in dilute hydrochloric acid and heated until the solution is complete.

Fused Clays and Refractories

Barrett and Schroeder (*J. Amer. Cer. Soc.*, 8, 69 (1925)), in their investigation of the methods available for the analysis of aluminous silicate refractories, found that with any of the common fluxes the analysis of fused clays and refractories constituted a difficult problem, owing to their infusibility. In their experiments they used fused clay and artificial sillimanite which had previously been ground to pass through 300 mesh. The material was mixed with 10 to 30 parts of sodium carbonate in a platinum crucible, and heated over a blast lamp for periods as long as six hours. The melts, when cooled, were dissolved in hot dilute hydrochloric acid, but in every case investigated a residue of unattacked material

remained in the platinum crucible. After grinding this residue in an agate mortar, fusing again with more sodium carbonate for an hour or two, and dissolving in dilute hydrochloric acid, a large proportion of the residue still remained unattacked. Similar experiments to obtain fusions with potassium carbonate, with mixtures of the two alkali carbonates, and with potassium bisulphate were not successful, nor were two fusions, first with potassium bisulphate, and secondly, the residue from that melt with sodium carbonate.

Although such materials are quite easily fusible in sodium peroxide, using a nickel, silver, or iron crucible, this has the great disadvantage that the alumina cannot be determined in the solution of the melts, because of the large amounts of the crucible metal which are also dissolved by the sodium peroxide, and the attendant difficulties which result from attempting to remove the dissolved metals from the solution of the melt. Fusion with mixtures of borax and sodium carbonate, whilst quite successful, suffered the objection that it is very difficult to remove all of the borax.

The method found most satisfactory depends upon fusing the material first with sodium carbonate and then with potassium bisulphate. About 0.5 g. of the material, after being ground to pass 200 mesh, is mixed with ten times its weight of sodium carbonate in a platinum crucible, and heated strongly for thirty minutes. The melt is taken up with water and dilute sulphuric acid. If considerable gelatinous silica is left after this fusion, it is advisable to fuse the residue with more sodium carbonate before proceeding with the potassium bisulphate fusion. After filtering, the residue is ignited and fused with several grams of potassium bisulphate. The extracts from these fusions are mixed together and acidified with about 10 c.c. of sulphuric acid, and evaporated until copious fumes of sulphur trioxide are evolved. After diluting with a few c.c. of hydrochloric acid and boiling until all calcium sulphate is dissolved, the solution is filtered and the silica residue collected, ignited in a platinum crucible and weighed, after which it is treated with hydrofluoric acid and a little sulphuric acid, evaporated and ignited. The silica is thereby volatilised as silicon tetrafluoride. The residue from this treatment is fused with potassium bisulphate, dissolved in dilute sulphuric acid, and added to the main solution. The alumina is determined according to the method of Blum (W. F. Hillebrand, *The Analysis of Silicate and Carbonate Rocks*, U.S. Geol. Survey, Bull. 700 (1919)). The combined precipitates of iron and alumina are carefully ignited to constant weight at a temperature of about 1150° C., and the iron and other constituents are then determined by any one of the well-known methods.

Sand as Pavement Filler

IN an interesting article on stone paving practice, Mr. C. M. Pickney, chief engineer, Public Works, Manhattan, N.Y., gives some serviceable information on asphalt paving cement and dry sand used as filler between granite blocks in New York City. In the borough of Manhattan, the joint filler used consists of the asphalt paving cement and hot dry sand used in proportions of four parts of sand to six parts of cement (by volume). The addition of the sand increases the stability of the filler materially, gives great economy, and imparts a wearing quality. Since the introduction of the sand, the filler does not run out of the joints on grades or into the gutters where it is necessary to make a slightly higher crown than usual. The object of this joint filler is to keep the blocks upright, to preserve their aris, to reduce noise, and to render the pavement waterproof. Another advantage is that the joint readily adapts itself to opening up of the pavement without destroying the granite, and it can be restored and opened to traffic immediately. The granite filler specified in Manhattan is obtained by the distribution of an asphaltic petroleum, carefully refined. In preparing the filler, best results are obtained by maintaining the asphalt in boilers in the street at a temperature of 325° to 400° F., determined by equipping the boilers with thermometers. The sand, all of which must pass a 10-mesh sieve and not less than 85 per cent. pass a 20-mesh sieve, is heated to a temperature between 300° and 400° F., the filler being poured into the joints within these limits.

China Clay from South Africa

Report of an Investigation at the Imperial Institute

It is stated in the July number of the *Bulletin* of the Imperial Institute that deposits of China Clay have been found in several localities in the Union of South Africa, and a report is given dealing with a sample of material from an occurrence at Claremont, near Cape Town. The sample was sent to the Imperial Institute in order that it might be compared with Cornish China Clay of good quality, and its commercial possibilities investigated. The sample, as received, consisted of a white China Clay contaminated with quartz sand in fragments up to $\frac{1}{16}$ inch in diameter. It was evident that the raw material would need purification before it could be employed for purposes similar to those for which Cornish China Clay is used, and trials were, therefore, carried out in the Imperial Institute ceramic laboratory in order to ascertain what degree of improvement could be effected by careful washing.

Washing Experiments

Comparative trials were carried out on samples of the South African raw clay and Cornish China Clay rock, the speed of the current of water being such as had been found necessary to remove the fine clay from the English raw material. Under these conditions the South African clay left 8 per cent. of residue, whilst the Cornish rock yielded about 57 per cent. The washed clay yielded by the South African material had the same appearance as refined Cornish China Clay, but contained rather more grit, a feature detrimental to its employment as a high-grade filler. With a view to eliminating this defect, further washing trials were made, using a much slower speed of water current for washing. Under these conditions the clay gave a residue of 15 per cent. The washed clay, however, was still much more gritty than refined Cornish China Clay of good quality, and a chemical analysis showed that it had practically the same chemical composition as the clay produced in the first trial by washing the raw material in a more rapid current of water. It is evident, therefore, that by further diminishing the speed of the current, a lower yield of refined product would be obtained without appreciable improvement in quality.

Deflocculation Process

The washed South African clay was similar in texture and colour to commercial samples of second-grade English China Clay used in the manufacture of the best grades of newspaper. It had the advantage, however, that it remained suspended in water for a longer period than did the English commercial sample. As it appeared evident that no further appreciable improvement would be effected by alterations in the mode of washing the clay, experiments were carried out in order to determine whether a material of better texture could be produced by other means. Trials were, therefore, made with deflocculation processes, and it was found that considerable improvement could be effected in the physical condition of the clay. The clay was mixed with water containing a very small quantity of sodium silicate, this treatment causing deflocculation of the fine clay, which remained in suspension whilst most of the gritty particles rapidly settled out and were removed. The purified clay could then be recovered by electrical osmose treatment or by adding to the solution a coagulant such as a weak solution of aluminium sulphate.

In order to determine the suitability of the washed clay (not deflocculated) for use in the manufacture of earthenware and china, the following mixtures were made, using the washed South African clay:—

	Per cent.
(1) Earthenware:	
South African clay	35
Dorset ball clay	30
Flint	20
Cornish stone	15
(2) China:	
South African clay	30
Bone ash	35
Cornish stone	35

Similar mixtures were also made, using English China Clay in place of the South African material, and essels moulded from the earthenware and china mixtures were fired to a temperature of about $1,150^{\circ}\text{C}$. and $1,250^{\circ}\text{C}$. respectively. It was found that there was little difference in appearance between the earthenware made with the South African clay

and that made with the English kaolin. A somewhat lower firing temperature, however, would be adequate.

It was found that South African clay and the earthenware mixture made therefrom had somewhat higher shrinkages than those of the corresponding products containing Cornish China Clay, but the difference in shrinkage between the two earthenwares was not sufficiently great to be of any practical importance. The bone china produced from the South African clay by firing at a temperature of about $1,250^{\circ}\text{C}$. and covering with a felspathic glaze was similar in appearance to that made with English kaolin.

Summary and Conclusion

The raw China Clay from Claremont, on washing, gave a high yield of China Clay which could be used in the manufacture of china and fine earthenware. The washed clay, however, was in all cases rather gritty, and would be comparable only with second-grade Cornish kaolin used as a filler for high-grade newspaper. Extensive experiments were made with a view to obtaining a better product, and it was found that this could be effected by deflocculation processes.

China Clay Production

Improvement in Methods

In the early days of the industry a good deal of the China Clay was washed by hand, and women were engaged for the work. Instead of being washed, as is now the case, in the pits and conveyed in its liquid state to the surface, the virgin clay was dug out of the pits and conveyed in hand-barrows to primitive wood troughs, the forerunners of the present-day micas, and after impurities had been removed by a laborious and crude process the China Clay was placed in large square earthenware pans and sun and air dried.

From the old washing of the clay, and its drying by the aid of sun and air, to the present modern clay-works equipment and drying kilns is a far cry. The intervening period has been marked by many great improvements for dealing with the huge quantities of clay now required, although very little improvement has been made on the original methods for the actual winning and preparation of the clay for the market. The improved methods and contrivances have had for their object more rapid and cheaper production. The last 60 years have taught the producers many lessons. Nowadays, practically every new China Clay works, where the clay is raised, is connected with a pipe line, in many cases several miles in length, to the dries alongside railways or ports of shipment.

Years ago the dries were on a comparatively small scale, but nowadays few dries are erected with a capacity less than 10,000 tons per annum. In the pits, where 60 years ago the work was done exclusively by manual labour, new hydraulic hoses and sluices are being used and are superseding and taking the place of men known as "breakers" and "washers," men who break the crude clay in the course of streams running down the sides of the pits.

Introduction of Modern Machinery

The old-fashioned pumping engines and gears have given place to powerful pumps driven by modern gas, electrical, and steam engines capable of pumping hundreds of tons of liquid clay to the surface per week. For the blasting of hard ground, rock drills are now superseding the old method of drilling holes. Electrically driven platforms are in use in some dries, steam navvies and mechanical conveyors are being utilised for the removal of overburden, and some works have introduced aerial ropeways where these can be effectively employed.

While so many dries are now linked up with the railway sidings and ports of shipment, works at a distance from these points of despatch used to rely exclusively upon horse-drawn wagons for the carriage of their clay. These works are now finding themselves handicapped by the present-day necessity for more expeditious loading, and there is now a totally inadequate number of horse-drawn wagons available for this traffic, so that the more general adoption of mechanical transport has been imperative. The most significant development to-day is the application of mechanical appliances to every department of China Clay production where they can be economically utilised. With the present high prices of materials and labour the introduction of all kinds of economies is essential.

China Clay Notes and News

Cornish Unemployment

The following were the numbers of unemployed on the books of the Labour Exchanges in the various towns mentioned at the end of June:—Fowey, 86; Newquay, 19; St. Austell, 286; St. Columb, 40; Bodmin, 38; Callington, 13; Camelford, 19; Gunnislake, 35; Liskeard, 99; Wadebridge, 42; Saltash, 38; Torpoint, 85.

Reconstructed China Clay Company

Lantern China Clay Co. (1927), Ltd. Private company. Registered June 17. Capital, £4,000 in £1 shares. Objects: To acquire the business carried on by the Lantern China Clay Co., Ltd.; to carry on the business of China Clay manufacturers and merchants; to acquire any other China Clay works, beds, or quarries of China Clay and China Stone in Cornwall, etc. The directors are: A. Hutson (chairman), 2, Beach Lawn, Waterloo, Liverpool; F. W. Heape, 18, Riversdale Road, West Kirby, Cheshire. Remuneration as fixed by the company. Solicitors: Bremner, Sons, and Corlett, 1, Crosshall Street, Liverpool.

St. Austell Merchant's Estate

Mr. Reuben Nicholas Rogers, merchant, who was prominently interested in China Clay undertakings, left £10,463, with net personalty £8,378. Probate has been granted to his widow, Mrs. Janie Rogers, of the same address; his daughter, Mrs. Marian Louise Michell; and Mr. Archibald Shaw, surgeon, both of St. Austell. The testator left his premises, 28 and 30, Fore Street, St. Austell, in trust for his daughter, Marian Louise, for life, with remainder as she may appoint, or in default of appointment, then to the children of his sisters, Amelia Edwards, Ann Edwards, and Bessie Ruberry; and the residue of the property he left to his wife absolutely.

New China Clay Company Registered

Central Treviscoe China Clay Co., Ltd. Private company. Registered June 24. Capital, £3,000 in £1 shares. Objects: To carry on business indicated by the title. The subscribers (each with one share) are: S. J. Dyer, King's Avenue, St. Austell, China Clay merchant; S. P. Dyer, Ashleigh, St. Austell, China Clay merchant. The first directors are not named. Remuneration as fixed by the company. Secretary: S. P. Dyer. Solicitors: Stephens, Graham, Wright, and Co., St. Austell, Cornwall. Registered office: Market Hill, St. Austell. The business now converted into a limited liability company has for many years been carried on as a partnership concern in which Messrs. Dyer have been largely interested.

Paper Maker's Big Estate

The late Mr. Joseph Dixon, Oughtibridge, near Sheffield, head of Peter Dixon and Sons, Ltd., paper manufacturers, of Oughtibridge and Grimsby, who died in December last, left £377,366, with net personalty £360,610. Mr. Dixon was also financially interested in China Clay works. Among the bequests are: £2,000 to the Sheffield Royal Infirmary; £500 each to the Free Hospital for Sick Children, Sheffield, and the Jessop Hospital for Women; £2,000 to the executors for the employees of Peter Dixon and Sons, not to exceed 40; 500 preference shares in Peter Dixon and Sons to Henry Edward Lanktree, secretary of the company; 300 ordinary shares in Gregory, Reddish and Co. to Henry Morgan, of the Clough Works, Deepcar; and a number of smaller legacies to employees.

G.W.R. Congestion at St. Austell

At the last meeting of the St. Austell Urban Council, severe censure was passed on the lack of adequate accommodation for goods traffic at St. Austell station. The Chairman, Mr. T. H. Williams, thought it was time the council took some action in calling the attention of the G.W.R. authorities to the great congestion at the St. Austell station, as a result of which serious loss was being inflicted upon the trading community. Trucks of goods were held up for days outside because they could not be dealt with at St. Austell. Goods from Plymouth took ten days, and when they arrived it was sometimes three or four days before they could be got into position for unloading. It was absolutely ridiculous, and a very serious matter for people who were under contract to supply certain goods and to do certain work. The fact was that the accommodation had not kept pace with the growing

goods traffic, and the present station was only adequate for passenger traffic. He thought the Council should make representations to the G.W.R., whose general manager, Sir Felix Pole, was a business man, and urge upon the company the necessity of making provision at their site at Polkyth for all their goods traffic, China Clay, coal, timber, and stone, reserving the present station for passenger traffic only. It was agreed to seek the co-operation of the Rural Council in a joint protest and in urging for adequate provision being made elsewhere for coping with the goods traffic.

Order for Cornish Granite

The famous granite quarries at De Lank, Cornwall, have secured from Sir Robert McAlpine and Sons (London), Ltd., an order to supply the whole of the granite for the new dock improvements at Tilbury. De Lank Cornish granite is the finest in the world, and can be obtained in large quantities. The quarries have been celebrated since the early part of the eighteenth century. So far back as 1756, Smeaton, the eminent engineer, obtained from De Lank the stone for the exterior of the first stone Eddystone Lighthouse. When the new Eddystone Lighthouse was built a century later, De Lank granite was again selected as the most suitable for this exposed building. The special suitability of De Lank granite for marine engineering and public works has caused it to be used in many important structures, such as the Tower Bridge and Blackfriars Bridge, London; Rochester Bridge; docks in Hull, Newport, and Tilbury, and even in far-off Bombay. The large size of the blocks which can be obtained was an important consideration in such undertakings, and the granite has a crushing strength of 1,171 tons to a square foot. The De Lank granite is a beautiful silvery grey, and has not only a fine appearance, but admits of a high polish, whilst the atmosphere, which often plays havoc with other stones, has little effect upon it. It has been used in the construction of many well-known buildings. It has also been used in the National Memorial to Nurse Cavell, and in the base of the National Cenotaph.

Valuation of China Clay Works

At the St. Austell Rural District Council meeting recently references were made to the big task before the Council in the preparation of the new valuation lists under the new Rating and Valuation Act.

It was reported that at the meeting of the Rating and Valuation Committee (Mr. E. B. Vian, chairman), a letter was read from the China Clay Producers, Ltd., asking if the Rating Committee wished the companies to fill out the ordinary form of rating return. The Clerk having reported that he was going into the question with Mr. A. Body, the rating surveyor, it was resolved that the matter be left in their hands and that the China Clay Producers, Ltd., be thanked for their letter, and informed that the clay firms would not be required to fill out the ordinary rating forms.

It was reported that a letter was read from Mr. A. Body that it would be impossible to complete the first new valuation lists by April 1, 1928, and suggesting April 1, 1929, as the earliest date upon which the valuation lists could be brought into force. The Committee recommended accordingly, the Clerk being instructed to communicate at once with the East Central Assessment Committee. Mr. Jenkin pointed out that most of the Councils had agreed on April 1, 1928, as the date, and thought they should let the County know what they were proposing to do. The Clerk said it would be impossible to get the clay works valued before 1929. Few had any idea of the amount of the work there was to do in the matter. If Truro with fewer and simpler assessments required till April, 1929, to get through, there was all the more justification for St. Austell, where they had some 11,000 assessments in the most complicated industrial district in the county, requiring till that date. The recommendations of the Committee were adopted, and it was decided to notify the County Valuation Committee of the decision.

In order that the interests of the China Clay producers may be adequately safeguarded, China Clay Producers, Ltd., representing the industry, are seeking to act in a spirit of co-operation with a view to seeing that matters of valuation for rating purposes, which affect the industry so vitally, shall be on an easily workable and fair basis.

Shipping and Export News of the Month

We give herewith latest particulars relating to arrivals and sailings of ships engaged in the China Clay trade, at the principal British clay ports. Registered exports of China Clay, with countries of destination, and other shipping and export matters are dealt with.

Fowey Shipping—June, 1927

Arrived.	Name.	Sailed.	Destination.
June 1, s.v.	Industry	June 4,	Plymouth
June 2, s.s.	Grado	June 4,	Hajnasch
June 2, s.s.	Greta	June 4,	Stettin
June 3, s.s.	Cornish Trader	June 8,	Antwerp
June 3, s.s.	Siva	June 8,	Gothenburg
June 3, s.s.	Gouwestroom	June 9,	Amsterdam
June 3, m.v.	Lydia Cardell	June 9,	Aberdeen
June 3, s.s.	Primrose	June 8,	Bo'ness
June 4, s.s.	System	June 8,	Rouen
June 5, s.s.	Brier Rose	June 9,	Weston Pt.
June 6, s.s.	Fishpool	June 16,	Philadelphia
June 7, s.s.	Intaba	June 16,	Bombay
June 7, s.s.	Giancarlo	June 18,	Genoa
June 8, m.s.	Siam	June 17,	Los Angeles
June 8, s.s.	Mersey	June 9,	Ridham
June 9, s.s.	Gower Coast	June 11,	Birkenhead
June 9, s.s.	Sarnia	June 14,	Passages
June 10, s.s.	Rossmore	June 11,	Bo'ness
June 10, s.s.	Blush Rose	June 14,	Weston Pt.
June 11, s.s.	Ferdene	June 14,	Brussels
June 11, s.s.	Wyke Regis	June 15,	Antwerp
June 11, s.s.	Suomen Neito	June 17,	Kotka
June 11, s.s.	Moss Rose	June 15,	Runcorn
June 11, m.v.	Shortest Day	June 16,	Plymouth
June 12, s.s.	Goole	June 15,	Hull
June 13, m.v.	Shamrock	June 14,	Plymouth
June 13, s.s.	Loire	June 18,	Antwerp
June 13, s.s.	Ainderby	June 23,	Portland, Me.
June 13, s.s.	Wild Rose	June 16,	Preston
June 14, s.s.	Hayle	June 18,	Fleetwood
June 15, s.s.	Kilstroom	June 21,	Amsterdam
June 15, s.s.	Fendris	June 17,	Harburg
June 17, s.s.	Dunmore	June 18,	Manchester
June 17, s.s.	Ardglass	June 22,	Brussels
June 17, s.s.	Puffin	June 23,	Liverpool
June 18, s.s.	Mersey	June 21,	Ridham
June 19, s.s.	Meuse	June 23,	Antwerp
June 19, s.s.	Guelder Rose	June 23,	Runcorn
June 20, s.s.	Harbridge	June 30,	Philadelphia
June 20, s.s.	Bristol City	July 2,	Philadelphia
June 20, s.s.	Blush Rose	June 24,	Weston Pt.
June 20, s.s.	Brier Rose	June 23,	Fleetwood
June 21, s.s.	Seaforth	June 23,	Newlyn
June 21, m.v.	Stade	June 24,	Stockholm
June 21, s.s.	Horsham	June 25,	Grimsby
June 22, s.s.	Primrose	June 24,	Grangemouth
June 23, m.v.	Karnten	June 27,	Hamburg
June 23, s.v.	Eclipse	June 25,	Truro
June 23, m.v.	Lyhner	June 25,	Pentewan
June 24, s.s.	Pylades	June 29,	Methil
June 24, s.s.	Gouwestroom	June 30,	Amsterdam
June 26, s.s.	Hayle	June 29,	Larne
June 27, s.s.	Edern	June 28,	Rochester
June 27, s.s.	Joffre Rose	June 29,	Preston
June 28, m.v.	Mayblossom	June 29,	Pentewan
June 28, m.v.	Shamrock	June 29,	Plymouth
June 28, s.s.	Jungshoved	*	Portland, Me.
June 28, s.s.	Anfin	July 1,	Drammen
June 28, s.s.	Moss Rose	June 30,	Weston Pt.
June 29, m.v.	Hela Naval	June 30,	Gothenburg
June 29, s.s.	Pansy	June 30,	Runcorn
June 30, m.v.	Tille	*	Antwerp
June 30, s.s.	Edda	July 2,	Kotka
June 30, s.s.	Gower Coast	July 2,	Liverpool
June 30, s.v.	Giacomo	*	Genoa
June 30, s.s.	Afon Towey	July 2,	Brussels

* Signifies "In Port."

Charlestown Shipping—June, 1927

Date.	Vessel.	From
June 1, m.v.	Lydia Cardell	Fowey
June 1, m.v.	Mary B. Mitchell	Falmouth
June 2,	Rose	Penryn
June 14, m.v.	Dankward	Barnstaple
June 15,	My Lady	Runcorn
June 17,	Helena Anna	Newlyn
June 18,	St. Michael	Castletown
June 22, s.s.	James Tennant	Dartmouth

June 23, s.s.	Treleigh	Pentewan
June 28, m.v.	Romanie	Cardiff
June 29, s.s.	Lowland Firth	Cardiff
June 29,	Kate	Castletown
June 30, s.s.	Dunmore	Bury Port
June 30, m.v.	Anna	Blyth

Sailings

Date.	Vessel.	From
June 2, m.v.	Dietrich Hasseldieck	Wiborg
June 2, m.v.	Lydia Cardell	Aberdeen
June 4, m.v.	Mary B. Mitchell	Glasgow
June 9,	Rose	Kirkcaldy
June 16,	S. F. Pearce	Glasgow
June 16, m.v.	Dankward	Brachstad
June 18,	Helena Anna	Leith
June 21,	St. Michael	Nantes
June 22, s.s.	James Tennant	Tayport
June 25,	My Lady	Runcorn
June 25, s.s.	Treleigh	Preston
June 30, s.s.	Lowland Firth	Aberdeen

Par Harbour Shipping—June, 1927

Arrivals

Date.	Vessel.	From
June 3, s.v.	Lady Jean	Truro
June 8, s.s.	Magrix	Teignmouth
June 10, s.v.	Alexandra	Pentewan
June 10, s.v.	Frances and Jane	Falmouth
June 11, s.s.	Wheatblade	Newport
June 14, s.v.	Pet	Cardiff
June 14, s.v.	Via	Newport
June 14, m.v.	Heather Pet	London
June 15, s.s.	Eilbechtal	Torquay
June 15, s.v.	Trevellas	Cardiff
June 21, s.v.	Flying Foam	Falmouth
June 22, m.v.	Hope	Plymouth
June 23, s.s.	Westerham	Sharpness
June 25, s.v.	Englishman	Falmouth
June 25, s.v.	Pearl	Falmouth
June 27, s.s.	System	Blyth
June 28, s.s.	Robrix	Teignmouth
June 28, m.v.	Shortest Day	Plymouth

Sailings

Date.	Vessel.	Destination.
June 1, s.v.	Emma and Ester	Manchester
June 1, s.v.	Guiding Star	Runcorn
June 1, s.s.	Condor	Antwerp
June 3, s.s.	Treleigh	Preston
June 12, s.s.	Magrix	Greenhithe
June 13, s.v.	Lady Jean	Queenborough
June 15, s.v.	Frances and Jane	Newcastle
June 16, s.s.	Wheatblade	Garston
June 16, m.v.	Heather Pet	Newlyn
June 17, s.v.	Alexandra	Rochester
June 19, s.s.	Eilbechtal	Terneuzen
June 21, s.v.	Rhoda Mary	Gravesend
June 27, s.s.	Westerham	Rouen
June 28, s.v.	Via	Runcorn
June 28, s.v.	Trevellas	Garston
June 29, s.v.	Flying Foam	Gravelines

Par Harbour Tide Table, August, 1927

(British Summer Time Throughout.)

Day of Week.	Day of Month.	Morning.	Afternoon.	Height.
Monday	1	8.38	8.55	12.2
Tuesday	2	9.11	9.27	11.9
Wednesday	3	9.43	9.59	11.4
Thursday	4	10.16	10.34	10.10
Friday	5	10.53	11.13	10.4
Saturday	6	11.36	—	9.1
Sunday	7	0.2	9.33	9.6
Monday	8	1.6	1.43	9.6
Tuesday	9	2.21	2.58	9.1
Wednesday	10	3.34	4.7	10.8
Thursday	11	4.38	5.7	11.6
Friday	12	5.34	5.59	12.3
Saturday	13	6.22	6.45	12.8

Sunday ...	14	7.7	7.38	13.3
Monday ..	15	7.49	8.9	13.7
Tuesday...	16	8.29	8.50	13.7
Wednesday	17	9.12	9.34	13.3
Thursday..	18	9.55	10.16	12.8
Friday....	19	10.38	11.1	11.11
Saturday ..	20	11.26	11.55	10.11
Sunday ...	21	—	0.28	10.3
Monday ..	22	1.6	1.48	10.1
Tuesday...	23	2.33	3.15	10.5
Wednesday	24	3.54	4.29	11.0
Thursday..	25	5.0	5.27	11.8
Friday....	26	5.51	6.13	12.2
Saturday ..	27	6.33	6.52	12.4
Sunday ...	28	7.10	7.26	12.7
Monday ..	29	7.42	7.57	12.8
Tuesday...	30	8.12	8.26	12.6
Wednesday	31	8.41	8.56	12.3

E. CLEMENS, Harbour Master.

June Deliveries

Record Month of the Year

THE total trade done in June was the biggest for the year, the previous months this year having been: May, 81,224 tons; April, 83,995 tons; March, 76,558 tons; February, 76,912 tons; January, 72,899 tons. The balance in favour of this year, compared with the first six months of last year, is now 11,433 tons; the balance having dropped from 14,920 at the end of the five months through the tonnage dealt with in June last year having been greater than that of last month. A feature of the month's deliveries in June was the comparatively big tonnage of Ball Clay, it being nearly double any previous month's tonnage this year. China Clay deliveries showed an increase on the month of over 5,700 tons.

Port.	CHINA CLAY.		CHINA STONE.		BALL CLAY.		Totals.	
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Fowey ..	1927.	1926.	1927.	1926.	1927.	1926.	1927.	1926.
Charlestown	66,088	74,532	4,772	2,779	4,241	1,101	75,101	78,412
Par ..	3,135	2,741	—	—	—	—	3,135	2,741
Plymouth..	2,517	4,792	265	209	—	—	2,782	5,001
Falmouth..	1,650	857	—	—	—	—	1,650	857
Penzance ..	2,460	106	—	—	300	—	1,760	106
Looe ..	780	3,177	—	—	—	—	780	3,177
By Rail ..	207	—	—	—	—	—	207	—
	4,007	2,615	—	—	—	—	4,007	2,615
June ..	79,844	88,820	5,037	2,988	4,541	1,101	89,422	92,909
5 months ..	358,952	351,089	23,740	16,558	8,896	9,021	391,588	376,668
6 months ..	438,796	439,909	28,777	19,546	13,437	10,122	481,010	469,577

China Clay Exports for June

A RETURN showing the exports of China Clay, the manufacture of the United Kingdom, from the United Kingdom to each country of destination as registered during the month ended June 30, 1927:—

COUNTRY OF DESTINATION.	QUANTITY.		VALUE.	
	Tons.	£	Tons.	£
Finland	2,504	2,833		
Estonia	822	803		
Latvia	588	884		
Sweden	1,466	2,136		
Norway	631	741		
Denmark (including Farøe Islands)	23	46		
Germany	1,853	3,755		
Netherlands	2,023	4,200		
Belgium	6,318	10,405		
France	1,357	2,943		
Spain	953	2,208		
Italy	3,699	9,605		
Greece	5	31		
Bulgaria	4	29		
Egypt	11	35		
Iraq	1	3		
China	10	54		
United States of America	31,212	62,727		
Mexico	20	95		
Brazil	22	84		
Irish Free State	—	1		
Channel Islands	604	1,787		
Nigeria (including British Cameroons)	—	2		
Cape of Good Hope	—	2		
British India: Bombay, via Karachi	20	84		
Other Ports	3,463	13,325		
Madras	25	110		
Bengal, Assam, Bihar and Orissa	120	402		
Australia	37	250		
Canada	130	716		
Total	57,921	120,296		

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

[NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]

ASHFORD AND NACCOLT BRICK TILE AND POTTERIES, LTD. (late ASHFORD AND DISTRICT BRICK AND TILE CO., LTD.). Registered June 16, £6,000 debentures (filed under section 93 (3) of the Companies (Consolidation) Act, 1908), present issue £3,450; charged on lands and buildings at Naccolt, also general charge. *£5,000. January 17, 1927.

BOOTHWOOD PAPER MILLS, LTD. Registered June 14, £450 mortgage, to A. Payne, 11A, Old Millgate, Manchester, solicitor; charged on lands and factory and other premises at Boothwood, etc. *£4,500. December 28, 1926.

BURY PAPER MAKING CO., LTD. Registered June 18, £8,600 debentures, part of £30,000; charged on properties at Pilsforth, Heap, and Bury, also general charge (except uncalled capital). *£21,400 first mortgage and second mortgage up to £80,000 for guarantee to bank. July 16, 1926.

CAULDON POTTERIES, LTD., Stoke-on-Trent. Registered June 10, £22,500 debentures; general charge. *£250,000. August 30, 1926.

Satisfactions

ASHFORD AND NACCOLT BRICK TILE AND POTTERIES, LTD. (late ASHFORD AND DISTRICT BRICK AND TILE CO., LTD.). Satisfaction registered June 20, £3,000, registered March 19, 1923, and July 4, 1923.

DICKINSON (JOHN) AND CO., London, E.C., paper manufacturers. Satisfaction registered June 14, £9,241, part of amount registered July 1, 1912, and January 21, 1919.

China Stone Values

CHINA Stone, or as it is sometimes called, Cornish stone, from its being obtained in Cornwall, is a granite rock, chiefly composed of white or pale brown quartz and white felspar. It is essentially a quartzose, felspathic rock, the quartz, however, being much in excess of the felspar. The best qualities of stone contain fluorine, which greatly increases its fusibility. China Stone varies much in hardness, and while its constituent felspars are usually more or less decomposed by atmospheric agencies in the stone supplied to the potteries, the harder qualities are very durable, and being easily wrought, they have been much used locally for building.

China Stone is too hard to be broken down like China Clay. It has to be blasted and quarried in the same way as ordinary granite. There are four qualities mainly used in the ceramic industries, the best being employed in the manufacture of the finest china and porcelain. They are: (1) Hard purple, the rarest and best; (2) Mild purple, a similar rock but softer; (3) Dry-white, a soft white variety; (4) Buff, similar to white, but slightly tinged with yellow. Unlike China Clay, China Stone is restricted to use in the ceramic and enamel industries, and is employed largely by British potters in the body as well as the glaze of wares. It is also used extensively by foreign potteries for making the finest china and porcelain.

China Clay Imports for June

A RETURN showing the registered imports of China Clay (including China Stone) into Great Britain and Northern Ireland from the several countries of consignment during the month of June, 1927, is given below:—

COUNTRY WHENCE CONSIGNED.	QUANTITY.		VALUE.	
	Tons.	£	Tons.	£
Germany	2	5		
Belgium	9	63		
Channel Islands	248	495		
Total	259	563		

7
1
8
5
3
3
5
3

The China Clay Trade Review

The Official Organ of the China Clay Industry and the only Journal specially devoted to its interests. Published in the third issue of "The Chemical Age" each month.

All Editorial communications should be addressed to the Editor, "The China Clay Trade Review," Benn Brothers, Ltd., Bouverie House, 154, Fleet Street, E.C.4. All communications relating to Advertisements, Subscriptions, etc., should be sent to the Manager, "The China Clay Trade Review," at this address. Telegrams—"Allangas, Fleet, London." Telephone—City 0244 (10 lines).

The New All-in Association

As we go to press, we learn by wire from our St. Austell correspondent that at a meeting between the Executive Committee of outside China Clay producers and the board of the Best Clays Association at St. Austell, on Wednesday, the formation of an "all-in" association was agreed to.

The notes that follow, in which the question of the formation of such an association is discussed, were, of course, written before the decision was known.

New Hope for the Industry

At the beginning of last month there suddenly came to the knowledge of the committee, which last year nearly succeeded in establishing a new association, information that led them to think the time was again ripe for reviving the scheme which last year fell through because one firm, whose inclusion was considered to be essential, failed to respond at the last moment. Encouraged by the prospect that a further attempt might be more successful, the committee, under the leadership of Messrs. E. J. Hancock, J. Hoyle, and A. Perry, circularised all the producers, intimating that the Best Clays Association were prepared to hold their hand in the matter of forward contracts, to give the outside producers an opportunity to get together to consider an all-in association movement.

Hopeful Signs

The response to the circularising was so encouraging that a meeting of the trade was convened and held at St. Austell on August 12, at which the position was reviewed. As in the nature of things the meeting was a private one, we are not at liberty to give an account of its deliberations. That the result was so far satisfactory as to justify the continuation of the discussions leading up to accomplishment of the project, is seen in the brief announcement subsequently made in the Press that a committee was formed to wait upon the Best Clays Association with a view to carrying the scheme to embrace all sections into effect.

The Limitations of the Cartel

We have reason to believe that the keeping alive of the idea of an all-in association in this journal has led to the creation of an atmosphere favourable to its formation. A few months ago we explored in some detail the various ways in which the interests of the industry could be safeguarded, and advocated the cartel as the most promising and practicable for immediate accomplishment. The article referred to has been much canvassed and discussed by the trade, and its suggestions welcomed. If the industry is to reach the summit of its prosperity and to secure for its organisers and workers the full benefit from their enterprise, amalgamation and capitalisation must be the ultimate goal. With a cartel it is not possible to organise the industry as one entity, and while it is the intention of those who will be in the new all-embracing association to make its organisation as watertight as possible, the industry, as the operations of the cartel become effective and its advantages proved, will more and more be favourable to the one organisation-cum-capitalisation ideal. The setting up of the association would be a step towards

it, though in entering upon it now firms do not necessarily subscribe to the amalgamation dream.

The Industry's Tendencies

Apart from the desirability of forming a comprehensive association for the protection of the immediate interests of the producers, the industry is tending more and more to get into few hands, so that in time, if the acquisition of works continues along the same lines, amalgamation may ultimately be accomplished by a process of attrition. The cartel would therefore seem to be the best method for preserving the interests of individual producers and ensuring for them a share of the world's trade, instead of, as may otherwise be the case, their being satisfied with the trade that is left after the big and strong concerns have skimmed it, as they have been doing since the old Association broke up, as all outside the Best Clays Association have experienced to their cost.

The competition between the "insiders" (meaning the members of the Best Clays Association) and the "outsiders" (those at present on their own) is not going to be less keen in the future if the "all-in" association does not function; signs are not lacking that the best clay factor in securing business with common clays will be used more and more by the best clay producers. In other words, the best clay people will keep their end up whatever happens, and that they are able to do it is seen by the success which has attended their career as a Best Clays Association. The common clay producers, as distinct from the best clay producers who also produce common clays, have therefore a fine opportunity to rehabilitate their position in the trade by joining the new association and making it a success. If they do, one thing is certain, and we write with some knowledge of what is going on behind the scenes: those who remain outside the more comprehensive association will have a very lean time. Success is deserved, after such efforts have been made for establishing an organisation having for its objects the conservation of the interests of the industry as a whole and to serve as a bulwark against the invidious sapping operations of price cutters.

The break up of the old association has since proved, as many predicted, the worst piece of business folly ever committed by the China Clay industry.

Rating of China Clay Works

At the last Rural District Council meeting at St. Austell, under the Rating and Valuation Act, the operation of which the Council has decided to postpone until April, 1929, the rating and valuation committee in their report, submitted by their chairman, Mr. E. B. Vian, stated that the clerk (Mr. A. S. Coldham) reported that Mr. Body, of Plymouth (the valuer appointed by the Council), and himself had been in communication with representatives of certain China Clay companies in regard to the revaluation, and he suggested that, with a view to obtaining the goodwill of the industry at the outset, a conference should be called between the clay owners and that committee to discuss the question with their technical advisers, and to arrive, if possible, at some basis satisfactory to both parties. The proposal was approved, and the matter left in the hands of the chairman and clerk.

The Analysis of High Alumina Clays and Refractories.—(II).

By W. Singleton

The following is the conclusion of an article the first part of which appeared in the last issue of THE CHINA CLAY TRADE REVIEW (July 16).

THE procedure for the determination of silica, in cases where it is necessary to fuse the material with potassium bisulphate has already been described. Where sodium carbonate alone has been used, the melt is dissolved in dilute hydrochloric acid, the solution transferred to an evaporating dish and evaporated to dryness. When quite dry, the residue is baked at 100° to 110° C. for an hour, after which it is taken up with dilute hydrochloric acid, and the silica filtered off. The filtrate is again evaporated to dryness, baked, and again treated with hydrochloric acid and filtered. The two residues of silica are ignited and weighed, after which they are treated with hydrofluoric acid and sulphuric acid as previously described. One or two precautions are necessary in carrying out the ignition of silica precipitates. The burning filter paper should not be allowed to burst into flame or some silica may be lost, and care should be taken in the early stages to ignite the silica precipitate at as low a temperature as possible. The bottom of the crucible should not be at more than a dull red heat, since if too high a temperature is employed great difficulty will be encountered in completing the combustion of the carbon from the filter paper. The writer has experienced occasions when even several hours' careful ignition have failed to remove the last traces of carbon from the silica precipitate due to a too high temperature having been used in the early stages.

The methods for the determination of silica have become so standardised as to need no further comments here. The methods are capable of giving accurate results, and check determinations should agree within 0.3 per cent.

Determination of Alumina, etc.

Where potassium bisulphate is used to decompose the sample, weighable amounts of platinum are dissolved from the crucible. It is therefore necessary to remove these by treatment with hydrogen sulphide, the platinum sulphide being filtered off and the solution oxidised with bromine water before proceeding with the precipitation of alumina. This procedure occupies considerable time and may be avoided in ordinary work by weighing the crucible before and after fusion. The loss in weight is then deducted from the weight of the "alumina" precipitate. The alumina is determined in the usual manner, methyl red being used as an indicator, and great care should be taken in following the colour change. To prevent small amounts of the alumina precipitates from passing into the filtrate, it is advisable to wash the precipitate with a hot dilute solution of ammonium nitrate or chloride. The alumina precipitate should be strongly heated until the weight is constant.

To determine the iron oxide, the ignited alumina precipitate is fused with about six times its weight of potassium bisulphate. The heating is carried out carefully to avoid spluttering, and until the residue is all dissolved. The melt is dissolved in warm water acidified with 10 c.c. of 20 per cent. sulphuric acid. The solution is made up to 250 c.c., a portion of which is reserved for the determination of titanium. The remainder of the solution is reduced with zinc and sulphuric acid, if titanium be present only in small amounts. Where titanium is present in appreciable quantities hydrogen sulphide should be used as the reducing agent, because the zinc reduces the titanium as well as the iron, and high results are likely to be obtained. To the solution is added 3 c.c. of 10 per cent. copper sulphate solution, and the titration carried out with standard potassium permanganate solution (one c.c. being equivalent to 0.001 g. of Fe_2O_3) until a faint pink colour is obtained.

To determine titanium the filtrate previously set aside is transferred to a small Nessler cylinder, and one c.c. of hydrogen peroxide, free from fluorine, is added and the mixture shaken. The colour of this solution is compared with the colour of a known standard solution, preferably of a strength such that one c.c. of the solution is equivalent to 0.0001 g. of titanium dioxide. The percentage of alumina is obtained by deducting the iron and titanium from the total "alumina" precipitate.

The following rapid method for the determination of iron and alumina in clays may be used in the analysis of clays where great accuracy is not required. The fresh precipitate of iron and aluminium hydroxides obtained in the usual way is carefully washed until chlorides can no longer be detected in the filtrate with silver nitrate solution. The filter paper and its contents are placed in a beaker and a known excess of $\text{N}/2$ sulphuric acid added from a burette; 50 c.c. of the acid are added for each gram of the original material taken for the analysis. The solution is boiled for ten minutes, cooled, and two drops of a 0.02 per cent. solution of methyl orange added, after which the solution is titrated with $\text{N}/2$ sodium hydroxide until the red colour disappears. An equal volume of acidified water coloured with two drops of methyl orange may be used for comparison. The titration should be stopped at the point of the first change and not continued to yellow colour. The acid combined with the two oxides is calculated by difference in the usual way. 1 c.c. of concentrated sulphuric acid is added to the solution, which is reduced with hydrogen sulphide, and in the same beaker the iron is determined by titration with $\text{N}/10$ potassium permanganate. The presence of the filter paper in the solution does not appreciably affect the results, which are satisfactory and have the advantage of rapidity. Lucchisi (*Giorn. chim. ind. applicata*, 5, 12 (1922)) has examined this method and gives a number of examples where the alumina as determined by the above method was in each case within 0.2 per cent. of the value obtained by the ordinary method, whilst the iron oxide values differed by only 0.05 to 0.08 per cent. from the ordinary results.

Determination of Lime in Clays

The determination of lime in clays offers no special difficulty. After precipitating with ammonium oxalate and hydroxide, the solution is evaporated to 150 c.c., during which time the calcium oxalate will settle. It is then filtered and ignited to oxide or determined volumetrically with $\text{N}/20$ potassium permanganate. Where large amounts of alkali sulphates are present, the precipitate is allowed to stand overnight, as it has been found that in the presence of large amounts of alkali sulphates the calcium oxalate does not precipitate as readily as when they are absent. In such cases and in the presence of magnesia the precipitate should be filtered off, redissolved in dilute hydrochloric acid and reprecipitated. It will then settle quickly and be quite free from magnesium salts.

The determination of magnesium oxide may be carried out by the usual methods which are thoroughly described in most text books. It is necessary to point out that two precipitations are desirable, especially where the magnesium oxide is high and large amounts of alkali salts are present.

The well known Lawrence Smith method is recommended for the determination of the alkalis. The potassium in the mixed chlorides may be determined either by the chloroplatinate method or by the perchloric acid method. The latter is quite satisfactory, but is liable to give erroneous results in the presence of sulphates.

Institute of Clayworkers' Medal

At a recent meeting of the Institute of Clayworkers it was decided to present a gold medal annually "for conspicuous services rendered to the clayworking industry, either in the department of manufacture, science, art or literature connected with the same, or for any other form of service rendered that the committee might consider would merit the award."

It was unanimously agreed that the first gold medal should be presented to the honorary secretary of the Institute, Mr. H. G. Montgomery.

China Clay Imports for July

A RETURN showing the registered imports of China Clay (including China Stone) into Great Britain and Northern Ireland during the month of July, 1927, indicates that the imports were nil.

Removing Sand from Clay Works

An Account of Methods Used

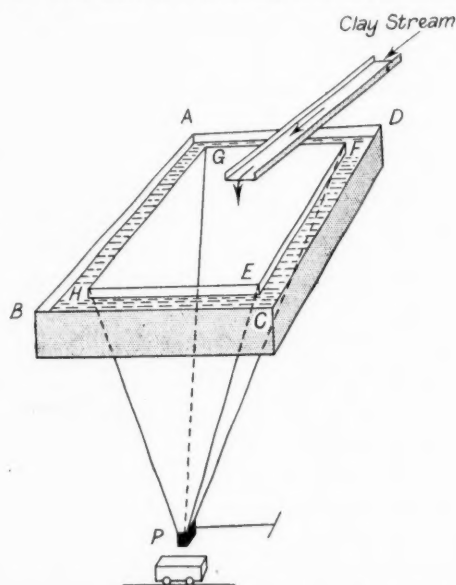
It is impossible to give statistics relating to the amount of sand deposited per ton of China Clay washed. It varies from pit to pit and from district to district. In some places three tons of sand may be removed per ton of clay washed, and in others eight tons of sand per ton of clay. In general, the China Clay pits of the mid-Cornwall area are not so sandy as some of the pits on Dartmoor. The rapid and cheap removal of this waste product is a matter of the first importance to China Clay producers.

Methods in Operation.—The old method of separating sand from clay is to dam or pool the stream so that the sand settles in a still pool, while the clay stream flows over the dam and thence to the micas to be further refined. The sand deposited in the sand pits is usually removed by hand labour—i.e., it is shovelled into wagons and hauled over the dump. A development of this method is the patent sand pit or sand box. The stream from the clay face, carrying the sand before it, is run into a sand box having a removable bottom or side, or both. A tramway is laid under the sand box, and when the box is full of sand, the bottom is taken away piece by piece, so that the sand falls into the wagon beneath, and is then hauled away and dumped.

A third method of removing sand is to pump it direct from the pit to the surface, or to some convenient level, with a sand pump capable of dealing with the sand and also small stones. This obviates the necessity for having sand boxes in the bottom of the pit, so that there is a larger area in the bottom over which clay may be washed. This method has been adopted in several works.

Development of the Patent Sand Pit.—A development or extension of the patent sand pit arrangement may be seen in at least one clay pit. Classifiers as used in tin mines, etc., have been adapted for use as sand boxes. The method of operation is as follows:—

The illustration (which is not drawn to scale) represents the classifier. E F G H P is an inverted pyramid into which the clay stream with its sand and small stones flows via the launder as shown. The sides E F G H are each about six feet long



CLASSIFIER ADOPTED FOR USE AS SAND BOX

and the depth, measured vertically from P to the level of E F G H is, say, eight feet. A B C D represents a launder placed around E F G H, so that when the inverted pyramid is full, the clay stream flows over the sides E F G H into the launder and thence by suitable means to the shaft, whence it is pumped to the surface. A double valve is fixed at P, the larger of the two being used only if the smaller should become choked by a stone or other solid obstruction. Under P is a wagon

into which the sand and stone collected in the box fall when the valve at P is opened.

Advantages and Disadvantages.—It is claimed that the arrangement described is a decided improvement on the patent sand box of rectangular shape with removable sides and bottom, in that a much greater volume of sand can be dealt with in the same time, and that shovelling by hand is entirely eliminated. It is also claimed that a large proportion of the very fine sand or coarse mica which usually finds its way into the shaft is trapped in the classifier, thus reducing appreciably the wear and tear of the shaft gear. With two or more classifiers in parallel, washing can proceed continuously and sand can be removed continuously and as rapidly as wagons can be shunted under P.

It has this disadvantage in common with the rectangular type of patent box—i.e., the clay can only be washed to the level of the top of the classifier and from 12 to 15 ft. of head for washing clay are lost. Combined with a sand pump delivering into a classifier or a battery of classifiers, the device is probably more efficient for dealing with large quantities of sand than the existing arrangements. It is essentially a device for those pits which have to deal with large quantities of sand.

E. J. L.

Handling of China Clay in India

Economies Effected

A RECENT account of the handling of China Clay in India indicates that the application of modern methods has resulted in considerable economy. The account, which appears in *The Indian Textile Journal*, is as follows:—

"One of the most important recommendations of the Textile Tariff Board is that the Bombay cotton mill industry should reduce their working charges by rigid economy wherever possible. The millowners themselves had pointed out that the Bombay Port Trust could do not a little towards the reduction of handling costs in the docks. But to achieve this the co-operation of the importing firms is also necessary. We are glad to notice that one leading firm has already taken steps to reduce its handling costs and thereby also the ultimate charges to the mills. China Clay, which is extensively used in the manufacture of cloth, was till now imported in the form of 5-cwt. wooden casks, a most cumbersome and costly method, considering that the annual imports exceed 20,000 tons.

Bulk Shipments

"With a view to cheapening costs, the Sizing Materials Co., Ltd., Bombay, who are the principal importers of China Clay, conceived the idea of importing the commodity in bulk shipments of 7,000 to 8,000 tons, and storing it in a specially constructed godown where it could be bagged and subsequently distributed to the local and up country mills according to their requirements. The company rented from the Port Trust a rail-and-road-served godown at Grain Depot, Mazagaon-Sewri Reclamation, capable, after suitable structural alterations, of storing some 10,000 tons of China Clay, and arrangements were also made with the Port Trust to ensure expeditious unloading ex-steamer into special railway wagons and ex-wagon into godown.

"When the first bulk shipment of 7,000 tons arrived recently by the s.s. *Elmpark*, the unloading was carried out by means of large iron tubs lifted by the hydraulic dock cranes and emptied into the rake of wagons kept ready alongside the steamer. Working continuously with 7 quay cranes and 59 special high-sided railway wagons of 20 tons capacity, an outturn of well over 1,000 tons per 8-hour working day was easily attained. The outturn could be considerably increased by working at night.

Advantages of New Method of Handling

"The advantage to the mills by this method as compared with that of wooden casks may be summarised as follows: The clay is deposited in the godown in 2-cwt. bags which can be handled conveniently. They can be weighed accurately a day or two prior to dispatch and thereby the loss through evaporation is almost eliminated. Owing to the plastic nature of the clay and the nature of the bags used in Bombay there is little fear of dusting out of contents. A further cheapening of Rs. 3 to 4 per ton is possible if the bags which remain intact are sold after being emptied."

China Clay Notes and News

Clay Company Manager's Retirement

A most enjoyable day was spent on July 30 by the manager, foreman and employees of the Anchor China Clay Co., Ltd., whose works are near St. Austell, when they visited Penzance, being conveyed thither by large new Great Western Railway motor 'buses. The event marked the retirement of their manager, Mr. John Hooper, from the active management of the Anchor Co.'s works, which he has so ably managed for the last 28 years. Previous to his connection with the Anchor Co., Mr. Hooper was with the firm of Pochin and Co., Ltd., for about eleven years in China Clay works, and over eight years as manager of their chemical works at Bristol and New-castle-on-Tyne, returning to Cornwall in August, 1898, as manager of the Wheal Frederick China Clay Co., Ltd. He founded the Anchor China Clay Co., Ltd., in 1899, a virgin property.

The progressive policy of the company under his management resulted in opening out the Anchor and Fal Valley pits, and the Melangoose China Clay Co., Ltd., and later on in the acquisition of the Kerrow Moor China Clay works. The combined works have to-day a standard output capacity of close upon 50,000 tons China Clay per annum, with six driers, 25 settling pits and 23 settling tanks, capable of storing 8,000 tons of dried clay and 18,000 tons of wet clay. After the dinner a gold watch, suitably inscribed, was presented to Mr. Hooper, the gift being subscribed for by the foreman and employees of the Anchor Co. References were made by Captain Pethick in his presentation speech and by representative men in their supporting speeches, to the long and cordial relations existing between Mr. Hooper and all those under him, and regret was expressed at his retirement.

Cobalt Stain

Difficulty is frequently experienced in obtaining consistently good results when cobalt oxide or cobalt sulphate is added to a white ware body. When the latter is slightly over-fired, a blue-grey cast will probably result. Divergence of opinion exists with regard to the best mode of procedure to adopt in order to avoid this defect. By the following method, one authority obtained satisfactorily uniform results. To prepare the stain, 15 oz. of pure cobalt sulphate was dissolved in 750 oz. of pure water. After adding 7½ oz. of sodium carbonate, the mixture was thoroughly stirred; not until after thorough blunging of the Ball Clay with the body should the stain be added. When 10 per cent. of Ball Clay is present in a body, ½ oz. of the stain should be added for every 1 lb. of the body. With any increase in the amount of Ball Clay used, the proportion of stain should be correspondingly increased. When, however, the Ball Clay content is as great as 16 per cent. of the body, no increase in the admixture of cobalt stain will result in a pure white product. When white ware glaze exhibits a yellow tint, this may be corrected by the addition of 10 per cent. of the cobalt stain to every 100 lb. of glaze which is ground. Should the percentage of lead be high, the amount of stain will, of necessity, be proportionately increased. Instead of the chromium compounds employed to produce a green glaze on terra-cotta, a deeper shade of that colour may be obtained when cobalt and uranium are introduced. Satisfactory results have been secured by the addition of 3 per cent. of cobalt sulphate and 6 per cent. of uranium oxide to a matt glaze, composed of potash 0.261, lime 0.306, zinc 0.294, barium 0.083, magnesia 0.057, alumina 0.384, and silica 2.08. In the foregoing mixture, a mottled appearance was produced when cobalt oxide was used, but when cobalt sulphate was substituted, there was no evidence of mottling. This defect did not display itself when cobalt oxide was introduced into the following bright glaze: potash 0.238, lime 0.354, zinc 0.210, barium 0.144, magnesia 0.055, alumina 0.428, and silica 2.90.

Mineral Coating Processes

CARBON PAPER. A. E. WHITE. ENGLISH PATENT 250,051. —Carbon paper is made from opaque paper, which is of the same colour and shade as the surface of the transfer material, which is applied on one side only, thereby ensuring that the appearance of the sheets shall remain substantially unaltered

by wear, and the consequent removal of the transfer material from the coated surface. The necessary opacity is preferably given to the paper during its manufacture by adding colour or pigment to the paper stock in the beaters. Instead of incorporating a pigment or colouring composition into the paper during its manufacture, a dye or a pigment such as carbon black, with a small amount of basic colour, such as methyl violet, may be applied to it before the application of the transfer surface.

MEANS FOR COATING ROOFING AND OTHER SIMILAR MATERIALS FOR COVERING BUILDING SURFACES. R. MACLEAN, ASSIGNOR TO AMALGAMATED ROOFING CO. U.S. PATENT 1,574,835.—The object of the above invention is to provide coating mechanism whereby the manufacturer of mineral-surfaced roofing can easily and quickly change from one kind of surfacing material to another. The mineral surfacing material is delivered from a hopper into an equalising chamber, the bottom of which is closed by a feed-roll and an adjustable gate, by means of which the amount of mineral discharged can be regulated. The surfacing passes from the equalising chamber over an apron and on to a rotating brush, which ensures even distribution over the impregnated roofing as it passes under the brush. The hopper has a number of compartments for different surfacings; and when it is desired to change, the compartment from which material is being fed to the equalising chamber is closed, and as soon as the chamber is emptied, the appropriate compartment is opened.

The Anomalous Flocculation of Clay

From time to time notes on the above subject have appeared in this review. In a recent letter to *Nature*, Messrs. A. F. Joseph and H. B. Oakley sum up their position as regards some criticisms by Professor Comber. "It is a little difficult," they say, "to be sure of what Professor Comber means by the statement that 'Flocculation of clay by calcium salts is anomalous when considered in the light of prevalent theories,' when, perhaps, no theories on this question can be said to be prevalent. With regard to the facts (on which the theories ought to be based) we profess to have established the following:

"(1) Clay flocculated by dilute hydrochloric acid and then purified from electrolytes by dialysis or other means is nearly free from exchangeable bases.

"(2) Such clay (containing only 0.1 per cent. of replaceable calcium) is readily flocculated by sodium hydroxide: this seems in direct conflict with the last paragraph of Prof. Comber's letter. Further, kaolin and pure silica containing no exchangeable calcium can be readily flocculated by sodium hydroxide.

"(3) It is more easily flocculated by the chlorides than by the hydroxides of either sodium or calcium where the concentration of the base does not exceed 0.5 N and 0.002 N respectively.

"(4) At higher concentrations it is more easily flocculated by hydroxides than chlorides, and this is true both for sodium and for calcium.

"(5) In the case of suspensions of pure silica containing only particles less than 2μ diameter, flocculation cannot be brought about by the chlorides at concentrations up to normal, whilst in the case of the hydroxides, N/60 and N/10 are sufficient for calcium and sodium respectively to produce flocculation in one hour.

"(6) The flocculation of silica differs from that of clay in that the former is only flocculated by sodium or calcium chloride in an alkaline medium. The concentration required decreases with increasing alkalinity, and this also holds for clay above a p_H of about 9. If, however, a small amount of aluminium hydroxide is precipitated on the silica, there results an electro-negative suspension of which the behaviour towards flocculants is remarkably similar to that of clay. In particular, it shows the phenomenon of successive flocculation, deflocculation, and flocculation on the addition of increasing quantities of alkaline solutions of sodium chloride, as described in the case of clay in our previous letter to *Nature* (May 1, 1926, p. 624).

"These are the facts so far as we have gone: silica and clay are certainly different in respect to flocculation phenomenon, but it is better not to call either anomalous."

Shipping and Export News of the Month

We give herewith latest particulars relating to arrivals and sailings of ships engaged in the China Clay trade, at the principal British clay ports. Registered exports of China Clay, with countries of destination, and other shipping and export matters are dealt with.

Fowey Shipping—July, 1927

Arrived.	Name.	Sailed.	Destination.
July 1, s.s. Mersey		July 4, Ridham	
July 3, s.s. Ferndene		July 7, Rouen	
July 4, s.s. Goldbek		July 8, Boston	
July 6, s.s. Wild Rose		July 8, Preston	
July 6, s.s. Isolda		July 8, Looe	
July 6, s.s. Evelyn Manor		July 8, Terneuzen	
July 7, s.s. Taycraig		July 9, Weston Pt.	
July 7, s.s. Saint Enoch		July 9, Gravesend	
July 8, s.s. Fleiss		July 9, Manchester	
July 8, s.s. Hayle		July 9, Pasages	
July 8, s.s. Horn		July 9, Antwerp	
July 9, s.s. Gledburn		July 9, Seville	
July 9, s.s. Teeco		July 9, Weston Pt.	
July 10, s.s. Brier Rose		July 11, s.s. Moss Rose	Fleetwood
July 11, s.s. Moss Rose		July 11, m.v. A. H. Both	Reval
July 11, m.v. A. H. Both		July 11, m.v. Shamrock	Plymouth
July 12, s.s. P. L. M. 24		July 12, s.s. Gouwestroom	July 15, Amsterdam
July 12, s.s. Gouwestroom		July 12, s.s. Blush Rose	July 14, Weston Pt.
July 12, s.s. Blush Rose		July 13, s.s. Mounre	July 15, Liverpool
July 13, s.s. Mounre		July 13, s.s. Rossmore	July 16, Bo'ness
July 13, s.s. Rossmore		July 13, s.s. Guelder Rose	July 16, Weston Pt.
July 13, s.s. Guelder Rose		July 13, s.s. Joffre Rose	July 16, Weston Pt.
July 13, s.s. Joffre Rose		July 13, s.s. Primrose	July 16, Preston
July 13, s.s. Primrose		July 14, m.v. Shamrock	July 15, Plymouth
July 14, m.v. Shamrock		July 14, s.s. Teesbridge	July 20, Philadelphia
July 14, s.s. Teesbridge		July 14, s.s. Ferndene	July 18, Pasages
July 15, s.v. Lady Jean		July 15, s.v. Tynebridge	July 22, Rochester
July 15, s.v. Tynebridge		July 15, m.v. Kongedybet	July 22, Portland, Me.
July 15, m.v. Kongedybet		July 16, s.s. Vega	July 28, Stettin
July 16, s.s. Vega		July 18, m.v. Kathe Jurgensen	July 21, Hamburg
July 18, m.v. Kathe Jurgensen		July 18, s.v. Alfred Rooker	July 21, London
July 18, s.v. Alfred Rooker		July 18, s.s. Seaforth	Aug. 1, Rouen
July 18, s.s. Seaforth		July 18, s.s. Teespool	July 26, Philadelphia
July 18, s.s. Teespool		July 20, s.s. Moss Rose	July 23, Garston
July 20, s.s. Moss Rose		July 20, s.s. Glynconwy	July 22, Liverpool
July 20, s.s. Glynconwy		July 20, s.s. Farfield	July 23, Grimsby
July 20, s.s. Farfield		July 20, m.v. Katie	Aug. 1, Greenhithe
July 20, m.v. Katie		July 20, s.s. Hayle	July 23, Preston
July 20, s.s. Hayle		July 21, s.s. Drakepool	July 29, New York
July 21, s.s. Drakepool		July 21, s.v. Fanny Crossfield	July 25, Granton
July 21, s.v. Fanny Crossfield		July 21, s.s. Dunmore	July 27, Preston
July 21, s.s. Dunmore		July 21, s.v. Jane Banks	July 27, Runcorn
July 21, s.v. Jane Banks		July 22, s.s. Clydeburn	July 25, Brussels
July 22, s.s. Clydeburn		July 22, s.s. Pearl	July 27, Runcorn
July 22, s.s. Pearl		July 22, s.s. Mersey	July 26, Ridham
July 22, s.s. Mersey		July 22, s.v. Isolda	July 23, Drammen
July 22, s.v. Isolda		July 22, s.s. Blush Rose	July 27, Weston Pt.
July 22, s.s. Blush Rose		July 25, s.s. Joffre Rose	July 28, Runcorn
July 25, s.s. Joffre Rose		July 25, s.s. Brier Rose	July 28, Runcorn
July 25, s.s. Brier Rose		July 26, s.s. Ferndene	July 28, Harburg
July 26, s.s. Ferndene		July 26, s.s. Gouwestroom	July 30, Amsterdam
July 26, s.s. Gouwestroom		July 26, m.v. Hele Naval	July 29, Par
July 26, m.v. Hele Naval		July 28, s.s. Elvier	July 30, Antwerp
July 28, s.s. Elvier		July 28, s.s. Deneside	July 28, Par
July 28, s.s. Deneside		July 28, s.s. India Maru	July 28, Portland, Me.
July 28, s.s. India Maru		July 30, s.s. Stanwell	July 30, Hull
July 30, s.s. Stanwell		July 30, s.s. Primrose	July 30, Preston
July 30, s.s. Primrose		July 30, s.s. Horn	July 30, La Palice
July 30, s.s. Horn		July 30, s.v. Happy Harry	July 30, Weston Pt.
July 30, s.v. Happy Harry		July 30, s.s. Annfin	July 30, Sarpsborg
July 30, s.s. Annfin		July 30, s.s. Tanny	Aug. 1, Charlestown
July 30, s.s. Tanny		July 31, s.v. Irish Minstrel	July 31, Weston Pt.
July 31, s.v. Irish Minstrel		July 31, s.s. Hayle	July 31, Runcorn

* Signifies "In Port."

Charlestown Shipping—July, 1927

Date.	Vessel.	From
July 1, m.v. Conrad Luhning		Exeter
July 1, Goldfinch		Falmouth
July 2, Maralie		Dartmouth
July 2, Crown of Denmark		Exeter
July 7, s.s. Eastoft		Weymouth
July 11, s.s. Stanwell		Brest
July 11, c.v. Petersen		Wiborg
July 11, Guiding Star		Looe
July 11, s.s. Horsham		Penzance

July 12, Johanna	Exeter
July 12, Hero	Falmouth
July 12, s.s. Westdale	Cardiff
July 13, La Revanche	Padstow
July 13, s.s. Reedness	London
July 16, Waterwitch	Falmouth
July 16, s.s. Jolly Laura	Truro
July 17, s.s. Margareta	Wiborg
July 19, St. Michael	Nantes
July 23, s.s. Oak	Falmouth
July 23, Gauntlet	St. Ives
July 24, Mary Sinclair	Falmouth
July 25, Dietrich Hasseldieck	Exeter
July 25, Hilda	Newlyn
July 26, Brooklands	Ayr
July 27, s.s. Edern	Newhaven
July 28, s.s. Magrix	Cork

Sailings

Date.	Vessel.	Destination.
July 1, s.s. Dunmore		Fleetwood
July 2, s.s. Maralie		Brussels
July 2, Kale		Runcorn
July 2, Crown of Denmark		Antwerp
July 4, m.v. Rommie		Nantes
July 5, Goldfinch		Rochester
July 8, Anna		Antwerp
July 12, s.s. Eastoft		Greenhithe
July 12, s.s. Stanwell		Leith
July 13, Guiding Star		Runcorn
July 14, s.s. Horsham		Sunderland
July 14, Hero		Runcorn
July 15, m.v. Conrad Luhning		Wiborg
July 15, m.v. Johanna		—
July 16, La Revanche		Nantes
July 19, s.s. Jolly Laura		Antwerp
July 19, s.s. Reedness		London
July 19, Waterwitch		Runcorn
July 22, St. Michael		Nantes
July 26, s.s. Oak		Fleetwood
July 27, Mary Sinclair		Glasgow
July 28, c.v. Petersen		Friedrichshald
July 29, Dietrich Hasseldieck		Wiborg
July 29, Hilda		London
July 29, Margareta		Grangemouth
July 30, s.s. Magrix		Gravesend
July 30, Gauntlet		Runcorn
July 30, s.s. Edern		London

Par Harbour Shipping—July, 1927

Arrivals

Date.	Vessel.	From
July 4, s.s. Rosabelle		Gravesend
July 8, m.v. Isabel		Poole
July 8, m.v. Isabel		Porthleven
July 11, s.v. Fred Everard		London
July 12, s.s. Fleiss		Trangsum
July 12, s.v. Leader		London
July 13, s.s. Christina		Cardiff
July 13, m.v. Talisman		Looe
July 14, m.v. Kathe Jurgensen		Newport
July 15, s.s. Seaforth		London
July 16, s.s. Snow Queen		Littlehampton
July 19, s.v. Isabella		Falmouth
July 20, s.s. Jolly Norman		Kingsbridge
July 21, s.s. Continental Pioneer		Plymouth
July 24, s.v. Lady Daphne		Truro
July 25, s.v. S. F. Pearce		Salcombe
July 25, m.v. Hetty		Plymouth
July 26, m.v. Lee Lee		Antwerp
July 26, s.s. Knowlgrave		Charlestown
July 27, s.s. Deneside		Plymouth
July 27, s.s. Rosabelle		Cowes
July 28, m.v. Hela Naval		Kristineham
July 30, s.v. Rothersand		Falmouth
July 31, s.s. Southwell		Morieux
July 31, s.v. Ryelands		Mousehole

Sailings

Date.	Vessel.	Destination.
July 1, s.v. Pearl		Runcorn
July 1, s.s. System		Newcastle
July 2, s.v. Pet		Weston Point

July 2, S.V. Englishman	Weston Point
July 7, M.V. Hope	Pentewan
July 8, M.V. Shortest Day	Plymouth
July 11, S.V. Snowflake	Weston Point
July 11, S.S. Rosabelle	Weston Point
July 11, M.V. Isabel	Weston Point
July 11, M.V. Isabel	Salcombe
July 15, S.V. Fred Everard	Rochester
July 16, S.S. Christina	Queenborough
July 17, S.S. Seaforth	Pentewan
July 18, S.S. Fleiss	Rotterdam
July 18, S.V. Leader	Gloucester
July 18, M.V. Kathe Jurgensen	Powey
July 20, S.S. Snow Queen	Weston Point
July 22, S.V. Isabella	Runcorn
July 22, S.S. Jolly Norman	Terneuzen
July 22, S.S. Continental Pioneer	Antwerp
July 28, M.V. Talisman	Looe
July 28, S.V. S. F. Pearce	Methil
July 28, S.S. Knowlgrave	London
July 28, S.S. Deneside	London
July 28, S.S. Rosabelle	Preston
July 31, S.V. Lady Daphne	Queenborough
July 31, M.V. Hetty	Gloucester

Par Harbour Tide Table, September, 1927

(British Summer Time Throughout.)

Day of Week.	Day of Month.	Morning.	Afternoon.	Height.
Thursday	1	9.10	9.24	11.11
Friday	2	9.38	9.53	11.3
Saturday	3	10.9	10.27	10.8
Sunday	4	10.47	11.10	10.0
Monday	5	11.37	—	9.5
Tuesday	6	0.10	0.50	9.2
Wednesday	7	1.34	2.19	9.7
Thursday	8	3.2	3.42	10.5
Friday	9	4.17	4.47	11.7
Saturday	10	5.12	5.30	12.8
Sunday	11	6.0	6.24	13.6
Monday	12	6.45	7.7	13.10
Tuesday	13	7.28	7.48	14.3
Wednesday	14	8.8	8.28	13.3
Thursday	15	8.48	9.9	13.9
Friday	16	9.29	9.50	13.0
Saturday	17	10.11	10.34	11.11
Sunday	18	11.0	11.30	10.9
Monday	19	—	0.6	9.10
Tuesday	20	0.47	1.33	9.6
Wednesday	21	2.21	3.6	10.0
Thursday	22	3.45	4.19	10.5
Friday	23	4.47	5.11	11.6
Saturday	24	5.33	5.53	12.1
Sunday	25	6.11	6.27	12.7
Monday	26	6.42	6.58	12.8
Tuesday	27	7.13	7.28	12.10
Wednesday	28	7.42	7.55	12.9
Thursday	29	8.8	8.21	12.6
Friday	30	8.35	8.49	12.1

E. CLEMENS, Harbour Master.

July Deliveries

JULY deliveries in all classes were down by 8,800 tons on the June figures, but were sufficiently large to maintain the total for the seven months of the year, nearly five thousand tons above the corresponding periods of the years 1926 and 1925. The 1925 total was 556,753. Taking the three classes separately compared with 1926 (seven months) China Clay is down by 9,402 tons, China Stone up by 10,588 tons, and Ball Clay up by 3,432 tons. A feature of July deliveries is the large quantity shipped through Charlestown, the record since pre-war. The serious congestion at St. Austell station probably accounts for the diversion of some of this traffic from the G.W.R.

Details:—

CHINA CLAY. Tons.		CHINA STONE. Tons.		BALL CLAY. Tons.		TOTALS. Tons.		
Port.	1927.	1926.	1927.	1926.	1927.	1926.	1927.	1926.
Fowey	53,966	68,183	5,785	4,674	1,504	1,463	61,255	74,320
Charlestown	7,621	3,377	—	—	—	—	7,621	3,377
Par	4,137	5,102	431	185	—	—	4,568	5,287
Falmouth	1,070	256	—	—	—	—	1,070	256
Plymouth	552	1,066	—	—	—	24	552	1,090
Penzance	1,793	992	—	—	—	—	1,793	992
By rail	3,742	2,194	—	—	—	—	3,742	2,194
Six Months ...	72,881	81,170	6,216	4,859	1,504	1,487	80,601	87,516
	438,796	439,909	28,777	19,546	13,437	10,122	481,010	469,577
	511,677	521,079	34,993	24,405	14,941	11,609	561,611	557,093

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

[NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]

MARLEY TILE CO. (LEIGHTON BUZZARD), LTD. Registered July 13, £5,200 debentures; general charge.

WALBERSWICK PEASANT POTTERY CO., LTD. London, W. Registered July 6, £600 Land Registry charge, to W. R. Read, c/o Bellord and Co., 8, Waterloo Place, S.W., wing commander, R.A.F., and others; charged on property in Portobello Road, Notting Hill. *Nil. June 23, 1925.

Satisfactions

HILL, PALMER AND CO., LTD. (late HILL, PALMER AND HEWS, LTD.), London, E.C., paper manufacturers. Satisfaction registered July 15, £100, part of amount registered September 25, 1924.

REDHILL TILE CO., LTD. Satisfaction registered July 13, £800 (not ex.), registered November 27, 1926.

London Gazette, &c.

Partnership Dissolved

W. AND A. J. PODMORE (William PODMORE and Arthur James PODMORE), manufacturers and millers of potters materials, at the Consall Mills, Consall, Staffs, the Station Mills, Consall aforesaid, the Caledonian Mills, Shelton, Stoke-on-Trent, the Mosty Lee Mills, Stone, Staffs, the Wetmore Mills, Stone, and the Clay Mills, Stretton, near Burton-on-Trent, by mutual consent as from July 11, 1927, so far as concerns A. J. Podmore, who retires from the firm. Debts received and paid by W. Podmore, who will continue the business under the style of William Podmore and Sons.

China Clay Exports for July

A RETURN showing the exports of China Clay, the produce of the United Kingdom from the United Kingdom to each country of destination as registered during the month ended July 31, 1927.

COUNTRY OF DESTINATION.	QUANTITY. Tons.	VALUE. £
Finland	1,557	1,980
Estonia	515	907
Latvia	494	490
Sweden	1,482	4,131
Norway	763	898
Denmark	572	1,499
Germany	1,637	3,485
Netherlands	4,265	8,602
Belgium	3,452	5,792
France	1,971	2,894
Madeira	—	5
Spain	2,375	6,073
Italy	1,365	3,524
Greece	11	65
Bulgaria	2	16
China	5	27
Japan	6	34
United States of America	23,178	47,518
Mexico	300	945
Costa Rica	50	213
Peru	5	23
Chile	4	115
Brazil	7	30
Uruguay	30	120
Argentina	10	68
Bombay, via Other Ports	647	2,506
Madras	9	38
Bengal	455	1,354
Straits Settlements	10	46
Australia	17	165
Canada	34	99
Irish Free State	1	5
Total	45,139	93,667

The China Clay Trade Review

The Official Organ of the China Clay Industry and the only Journal specially devoted to its interests.
Published in the third issue of "The Chemical Age" each month.

All Editorial communications should be addressed to the Editor, "The China Clay Trade Review," Benn Brothers, Ltd., Bouverie House, 154, Fleet Street, E.C.4. All communications relating to Advertisements, Subscriptions, etc., should be sent to the Manager, "The China Clay Trade Review," at this address. Telegrams—"Allangas, Fleet, London." Telephone—City 0244 (10 lines).

China Clay Trade Organisation

The announcement we were able to make in our last issue of the setting up of a new organisation for the better control of the industry has greatly improved the outlook for the future. Since the last "all-in" association came to grief the industry generally has suffered acutely from the lack of that understanding which was such a beneficial factor in the carrying on of business on remunerative lines before.

It would be a mistake to suppose that the new arrangement that has been arrived at is designed to put the screw on consumers and to raise prices to an inordinate figure. There is sufficient competition from the domestic clays of other countries, as well as from materials used in substitution for China Clays when the latter are too expensive, to exercise a salutary influence upon prices, even if the China Clay producers were disposed to profiteer with their products, which they are not.

The new association is concerned with other phases of the industry, as well as prices, a most important branch of its work being the sampling of clays and placing them in their appropriate grades. The grading of clays is by no means a simple process when it is borne in mind how great is the variety produced and the numerous purposes for which they are used. It should be a distinct advantage to buyers, whether they be middlemen or consumers, to be able to rely upon the qualities of the clays they buy, for under the system of grading a particular clay is not placed in a particular grade unless it is up to the standard of the class in which it is expected to be placed. Another advantage to the seller is that he can offer a particular clay at a price which will allow him a living margin of profit without the fear of being undersold.

An Association such as that now being set up is not in any sense a combine, inasmuch as each producing firm will continue to operate individually, retaining its own management, control, and selling organisation. The new organisation may be said to be a body working as the mouthpiece of the industry as a whole in all matters affecting its interests generally, and keeping a watchful eye on markets in a way that will be beneficial to the trade. Nothing is likely to be done to interfere with the good relations that have heretofore subsisted between the consumers and the producers of China Clay, nor is anything likely to be done detrimental to the legitimate interests of the industry. The successful operation of the new association, which will commence to function next year, will open up a new and brighter vista for one and all, and the trade can look forward hopefully.

American Purchase of China Clay Works

The acquisition of China Clay works in Cornwall by an American firm is something of an innovation in the China Clay industry, American buyers having hitherto been content to obtain their supplies as and when required from the Cornish producing firms. The move is a novel one on the part of the firm concerned, and indicates nothing more than a desire on their part to ensure a position of independence, for it must be recognised that with the absorption of best clay works by existing producing firms,

the scope for the purchase by buyers of best clays outside such firms becomes more and more restricted with each acquisition.

This American purchase does not indicate any concerted move to acquire any considerable section of the clay industry, and must be regarded as an individual transaction with no motive other than that of safeguarding direct supplies for this particular manufacturing and distributing American firm. Other considerable American buyers of English China Clays need be under no fear of being unable to obtain adequate and continuous supplies through English-producing firms, which will be made all the more easily available following the setting up of the new organisation in connection with the industry.

China Clay producing firms on this side, even those with direct connections with consumers in America, value too highly the pioneer work the middlemen over there have done for the development of the English China Clay trade to wish to do anything to make the selling of English China Clays by middlemen more difficult. It would, therefore, be a mistake to suppose that there is any concerted attempt being made by China Clay producers over here to squeeze out the American middlemen; rather the desire is to work in co-operation with them in expanding the trade.

At a time when great efforts are being made by American kaolin producers (backed by specious arguments that their domestic clays are "just as good" as the English product) to oust our clays from the U.S. markets, home producers are not disposed to act in any way detrimental to the interests of American middlemen who have done so much to foster the interest of consumers of our clays, which are better and more reliable, and possess qualities that are different from all other China Clays.

Clay Exports

The Board of Trade returns for August give the following figures as regards the export of clays: China Clay, including Cornish or China Stone, 60,287 tons, as compared with 58,138 tons in August, 1926, and 44,378 tons in August, 1925. The values for the three periods were £123,001, £120,020, and £83,470 respectively. For the eight months ended August 31, the exports were 432,175 tons, as compared with 455,945 tons in 1926 and 421,500 tons in 1925; while the corresponding values were £909,924, £944,520, and £877,673. As regards fireclay, exports during August amounted to 1,102 tons, as compared with 984 tons in 1926 and 1,336 in 1925, the values being respectively £2,213, £2,142, and £3,307; while for the first eight months of the year exports were 18,204 tons, as compared with 12,296 tons in 1926 and 15,406 tons in 1925, the corresponding values being £36,197, £27,849, and £36,153. Exports of all sorts of clay other than those listed above totalled in August 6,638 tons, as compared with 11,365 and 8,119 tons in 1926 and 1925 respectively, the values being £14,330, £23,874, and £15,984 respectively; while for the first eight months of the year the tonnage exported was 57,146 as compared with 73,154 in 1926 and 73,751 in 1925, the values being £126,255, £170,369, and £167,737 respectively.

The Plasticity of Clay

A Discussion of Possible Causes

The following is of interest as showing the views held on the Continent. It is translated from an article which appeared recently in the "Revue Matériaux de Construction."

ALL those who work with clay (states the Continental author) are aware of the fact that it is destitute of the required malleability, even after being washed and mixed. To obtain proper plasticity it must be kept in pits under certain conditions, and allowed to age until mature and plastic. This is true for all clays, including those used in ceramics, and kaolin. Large porcelain works are very careful to keep the clays exposed to the action of summer and winter weather before any preparation, and the nearer we approach the manufacture of fine ceramic ware the greater becomes the importance of ageing clay before use. The length of time for ageing a clay varies from about a year to at least three years, the latter being the minimum time for porcelain clay.

A strange legend regarding the manufacture of Japanese and Chinese artistic porcelain is current in technical circles. These industries have, from time immemorial, been handed down from father to son, and (according to the story) only use kaolin which was stored in pits by their great-great-grandfathers, whilst that put away to age by the existing owner will be utilised by his great-grandsons! This curious legend shows the great importance which is attached to ageing in the case of fine manufacture.

This necessity of leaving materials to the beneficent action of Nature, without any possibility of finding a substitute for the latter, is not peculiar to clay. We all know the favourable effect of age on wines and spirits. Perfumes and toilet soaps are affected in the same way, and Eau de Cologne owes its world-wide reputation to long ageing; nor has any artificial process yet been invented which gives good results. After ageing, clay acquires a more viscous structure. Endeavours have been made to mix viscous substances (such as soap or gum arabic) with the clay, but the products obtained were not the same as the seasoned clay. Apparently there is here an important field of investigation for the chemistry of colloids, yet in its infancy, which some day may supply us with information replete with interest.

The Ageing of Clay

The practical meaning of ageing is decomposition, seasoning of the clay, this process being as necessary for fine clay as it is for the kaolin for the manufacture of porcelain. Before this, however, there is another, equally important necessity, to obtain a regular uniform clay, viz., the disaggregation of the clay by wintering. Thus we must add wintering and ageing to the operations of preparation, thinning, moulding, drying, glazing, and firing. Before subjecting the clay to wintering it is often purified and then stacked in heaps or mounds, as far as possible in the direction of the N.E. and S.E. winds. For the action of frost, rain, inclemency of the weather to have a really efficacious action on the clay the lumps must be turned and washed with water, and this also makes it easier to remove foreign substances. The action of wintering is mechanical and chemical. If, for example, the clay contains iron sulphide and calcium carbonate, a ferrous sulphate is produced which in combination with the lime will give a more easily fired mass than if this transformation had not occurred. This chemical change, as also that of the organic matter always existing in greater or less quantity, allows the clay to disaggregate. During wintering the clay can also be thinned.

It must, however, always be remembered that these chemical and mechanical changes may have an unfavourable action when products of pure colour are required. Sometimes fine products are obtained with non-wintered clay which, after wintering, would give a defective colour. It has, in fact, been found that sulphates are formed by the decomposition of pyrites. Therefore, when purity of colour is essential and the clay contains pyrites, exposure to the weather will not be advisable. For some time, instead of wintering, a clay-cutting machine has been utilised. In the case of most clays wintering seems necessary to obtain the required uniformity, by a natural process, before subjecting the clay to the action of this machine.

Ageing in pits, not essential in the case of bricks, is necessary for porcelain, pottery, and grooved tiles. To prevent drying, the clay is covered with wet cloths. It can then attain its full plasticity. For clay to make grooved tiles, continuous pits are employed in the form of circular kilns or of shafts. In the latter, transformation of the clay takes place under a certain pressure, and disaggregation must be aided by watering.

Endeavours have also been made to mix the component parts of a clay as shown by analysis; that is, to carry out a kind of synthesis. After seasoning, however, the product was deficient in plasticity, and it was concluded that bacteria play a part in the transformation, though as yet there is no proof of this.

Removing Sand from Clay Works

To the Editor of THE CHINA CLAY TRADE REVIEW.

SIR,—As one who for years has made a close study of ways and means to remove sand speedily and economically, I read with interest the article in last month's *Review* on "Removing Sand from Clay Works," written over the initials E. J. L. The writer very fairly says that there are disadvantages with the method he advocates; he also claims advantages especially for settling more mica and for dealing with large quantities of sand. About the first—settling more mica—I should say that for a while, after turning the clay stream into an empty inverted pyramidal box having a depth of 8 ft., he would certainly trap all the mica, and it appears likely to me that a good deal of clay and commercial mica as well would remain in the sand: instead of "classifying," it would be more like "grouping" the various ingredients contained in the wash.

Personally, I would rather have a mica-drag between the sand-drag and inlet to pump, and another at the commencement of the micas.

His second point—dealing with large quantities of sand—appears to me (of course I am open to correction) as a statement that lacks substantiation. From what I can see by the sketch and dimensions given, it appears more like an experimental toy than a practical contrivance especially for dealing with large quantities. Take its size, 6 by 2 by 8 = 96 cubic feet; a yard wagon will, of course, carry 27 cubic feet, so it will hold when brimming full about 3½ wagon loads. Some of the larger works can haul 25 wagon-loads per hour over one incline, which would be 7 boxes of the size given. It is seldom convenient to have so many small pits, and even if there was room, it would keep the pit-minder nearly all his time turning the stream from one pit to another, and then with such a small sand storage, one could only "wash while hauling" or conversely "haul while washing," and what provision would there be for flood-time? The most serious defect from the speed standpoint, is that being so close on the wash it means wet sand: my experience has taught me that the drier the sand, the speedier and more economical to handle.

If one has three or four patent pits each with a capacity of from 80 to 100 cubic yards, and in rotating from one to the other, they are allowed to drain for a few hours before hauling, then only the trap-end is wet and sloppy (caused by excess of mica). The rest will drop into wagon tip in and out of skip without sticking, which makes for speed and economy. E. J. L. claims that shovelling by hand is entirely eliminated. I wonder! He seems to suggest by having two valves that hitches occur sometimes. I should reckon that one man would have to be in the "hopper" constantly splitting and scraping, while the other did the tramping. Instead of being more speedy than the patent pit, it would be less so. I have known one man fill and train 80 loads per shift, and very often, as I remarked before, two men will fill and tip into the skip 25 loads per hour after the first cut is taken out.

The classifier as described by E. J. L. may be a development of the patent pit, as it employs the same method—gravitation—to bring the sand to the wagon, but whereas the "earth-pull" in the patent pit is untrammelled as soon as the trap is out, in the pyramidal box it appears to me to be "cribbled, cabined and confined," and can only be got to the wagon by a surcharge of moisture or the stroke of the shovel, so I fail to see that it is an improvement.—Yours, etc.,

C. C. C.

New Cement Patents

Clay Constituents as Ingredients

THE following are abstracts of recently accepted specifications of new patents for the manufacture of cement. In each of them constituents found in China Clays enter into the composition.

Patent No. 250,246: Société Anonyme des Chaux et Ciments de Lafarge et du Teil, Viviers Ardèche, France.—This invention relates to cements containing a high proportion of alumina which have hitherto been called by the name "fused" cements, because they were manufactured by fusion in coke or electric furnaces from the raw materials bauxite and lime or limestone. It is based on the discovery that it is possible to bring about at much lower temperatures the intimate combination of the constituents and to obtain a cement of high hydraulic value (notwithstanding that the heating conditions prevent fusion and even clinkering as generally understood) by increasing the contact surface of the raw materials by pulverisation carried to an extreme degree; thus, for example, not more than 1 per cent. being rejected by a standard 180 by 180 meshes per sq. in. screen either by the dry or the wet method, the duration of heating being equally sufficient. It has been possible to vary the composition within the following limits: silica from 0 to 5 per cent.; alumina from 40 to 55 per cent.; iron oxide from 10 to 25 per cent.; lime from 20 to 40 per cent.; the proportion of lime varying from once to twice for the same given proportion of the other constituents without modifying the properties of setting and of strength.

It is possible, if considered advisable, to introduce the constituents of the ordinary mixture bauxite-lime in any form desired, either in a pure or combined state, wholly or partially; for example, limestone for the lime clay or hydraulic lime for the silica and alumina-iron ore siliceous or silico-aluminous or silico-alumino-limestone rocks. The furnaces employed for the baking may be of any type, provided that they allow a substantially constant temperature to be obtained during the time required for the heating, in the neighbourhood of 1,000° to 1,100° C. A tunnel furnace, for example, may be employed with advantage, or a furnace with plurality of chambers, in each of which combustion takes place successively by means of a suitable alteration of valves, the chamber or chambers preceding the chamber in which the combustion is occurring serving for cooling the baked bricks or agglomerates to be baked. The period of six hours suggested for baking at 1,000° C. can be substantially shortened when the temperature is raised whilst still keeping it clearly below the clinkering temperature. This makes it possible to use also a rotary furnace for the manufacture of the new cement, by carefully modifying and regulating the temperature (11 claims).

Patent No. 263,124: I. G. Farbenindustrie Aktiengesellschaft, 28, Mainzer Landstrasse, Frankfurt-on-the-Main, Germany.—It has already been proposed to utilise the residue obtained in the production of phosphorus pentoxide or phosphoric acid according to the volatilisation process, in which mixtures of phosphate sand and carbon are fused in a furnace in which the volatilisation process has been carried out, into a fused cement by the addition thereto of clay and aluminiferous constituents until a homogeneous cement mixture has been produced, which is thereupon tapped off and ground in the usual manner. This process, however, has the disadvantage that the ratio of the total amount of the slag to be melted in the furnace to the phosphorus thus obtained or to the phosphorus-containing products increases considerably in comparison to the ratio obtaining when the phosphorus production is effected without the aforesaid additions.

According to the invention the admixtures of calcareous, aluminiferous, or the like substances necessary for the formation of the cement clinker are added to the slag consisting mainly of calcium silicate only after the slag has been tapped off from the phosphorus furnace in the molten state, in contradistinction to the prior process, where the additions are effected in the phosphorus furnace itself. The amount of heat contained in the slag, depending on the additions and the degree of preliminary heating thereof, is usually quite sufficient for the formation of the clinker. In cases where the amount of heat contained in the slag may be insufficient for the formation of the cement clinker the liquid slag with its admixtures may be transferred into a separate furnace where the fusion is effected. The amounts of energy still

required for this purpose are relatively unimportant. The preliminary heating of the additions can be effected by means obtained in the process, for example, by the combustion of the carbon monoxide waste gases (6 claims).

Clay Works Fatality

Inquest on Dead Clayworker

ARISING out of an unusual accident at a China Clay works in the St. Dennis district last month, an inquest was held by Mr. M. F. Edyvean, of Bodmin, and a jury, of which Mr. T. Varcoe was foreman.

The accident occurred shortly after four o'clock in the morning at Parkendillick Works, and caused the death of Howard Joseph Hick, aged 20. Joseph Hick, father of the deceased, stated that his son worked at Parkendillick China Clay Works, the property of St. Dennis and Parkendillick China Clay Co., Ltd., of which Mr. R. J. Varcoe is the managing director. William Albert Hill said he was working in the pit at the same time and was shift boss. Hick was breaking clay with a dubber from the sides of the pit for witness to wash with the hose. Witness suddenly saw a big lump of clay falling from eight feet above where Hick was working, and after it had turned over, noticed that deceased had been knocked down, the lump having passed over him. He and others rushed to deceased, who appeared to be unconscious and did not move. The weather had been wet lately and the clay might have been waterlogged by the rain, but so far as he knew there were no cracks. They had electric light in the pit, daylight not having come in.

Inspector's Questions

In reply to Mr. R. King, Inspector of Mines, witness said he had not examined the face as it had not occurred to him that there was any danger. He was not aware that it was his duty to examine the face, but he was there to see that the men did their duty. In reply to Mr. L. Clements, Workers' Union organiser, of Liskeard, witness said the overburden was cleared back, so that there was no pressure due to that.

David Roberts, captain at the works, said that he last saw the working places in the pit the day before the accident between three and four o'clock in the afternoon. Everything was right so far as he could see then. There were no cracks in the side of the pit. He saw where the lump of clay came from. It was a three-cornered piece, and of a very clayey nature, and apparently slipped out. With reference to the last witness's evidence and his replies to Mr. King, witness admitted that the shift boss was in charge and knew what his duties were. In reply to Mr. King, witness said he had copies of the special rules posted up in the works. The last witness had the opportunity of seeing those rules like the others. He could not say without examining whether that pit was safe or not. The batter of the slope on which they were working was about 45 degrees. They were using electric lights, two being 100 volts and one of 60 volts. There was no question of insufficient light.

In reply to Mr. Clements, witness said that he could not say how recently the hose had been working on that section of the pit. As the shift boss was working on the same piece of clay he thought there was no danger.

The Jury's Opinion

The foreman of the jury said that they had visited the pit that morning and they considered the slope to the left of the place where the accident happened to be very dangerous, and it appeared to the jury a perfect death-trap. At one spot it was almost perpendicular and required a bit of mountaineering to get there. If anyone working there were to slip he would have no foothold whatever.

Captain Roberts said the place was not so risky as it might appear from below. He thought if the jury went there on the spot the place would not appear to be dangerous.

In reply to the foreman, the Inspector agreed that he was supposed to examine the pits, but could not do so every day. Dr. R. H. Manson said deceased died before he could be got to bed. His left arm was broken above the elbow and there were lacerated wounds on his right elbow. On his right side there was a large surface wound and three broken ribs. Death was due to shock following injuries. After a brief retirement the jury returned a verdict of accidental death due to a fall of clay.

China Clay Notes and News

Tehidy Minerals Dividend

TEHIDY MINERALS.—An interim dividend of 2½ per cent. less income tax at 4s. in the pound has been declared. A similar dividend was paid at this time last year, and the final dividend was one of 3d. per share, making the total for 1926 4½ per cent. Last year's interim was the first dividend paid by the company, which was registered in February, 1919, with an issued capital of £294,000 in £1 shares. The company is largely interested in China Clay properties as well as in tin mining.

Estate Agent's Retirement

Mr. George Gow, who has retired from the position of agent of the Tregothnan Estate for Viscount Falmouth, has been succeeded by Mr. H. C. Pinckney, F.S.I., late agent for Lord Furniss, Borough Court, Leicester, and Sir William Aykroyd, Grantley Hall, Yorks. Mr. Gow has been connected with the Tregothnan Estate for 35 years. He came to Truro first as resident agent under Mr. Hill, of London, and later became chief agent. Mr. Gow has left Truro and gone to Newquay to reside there. Lord Falmouth's estate extends to mid-Cornwall, and comprises a number of China Clay setts worked by clay companies.

Fowey Rates

At the last meeting of the Fowey Borough Council, it was reported that, after allowing for amounts to be received, a balance would remain on the urban account of £2,039 16s. 2d., for which a general district rate had to be levied. For the corresponding period of last year a rate of 3s. 5d. was made to obtain £2,138 7s. 4d. On the present assessable value a rate of 3s. 2d. would be required, which would bring in £2,071. The finance committee recommended a borough rate of 2d., to produce £160, and a general district rate of 3s. 2d., and the water committee recommended that the water rate for the half-year should be 4d., the same as before. These amounts together made a total of 3s. 8d. Alderman Shadwell proposed that the sums should be raised and the rates levied, and that £663 be transferred from the urban account to the water account. The report as recommended was adopted.

American Firm Buys Clay Works

The Paper Makers' Importing Co., of Easton, Pa., U.S.A., has acquired the well-known works of the Anchor United China Clay Co., Ltd., and the Melangoose China Clay Co., in the St. Stephens district. The Paper Makers' Importing Co. was among the pioneers of the English China Clay import trade in America, its founder, a Lancashire man (the late Mr. Knight) taking his first cargo of clay some sixty years ago. Before the War, the company superseded their system of buying through agents by establishing an office at St. Austell, which is under the management of Mr. F. S. Liddicoat. Mr. H. S. Knight, the president of the company, and Mr. C. Bryan, the vice-president, have often visited the district, more so of late in anticipation of being able successfully to negotiate the purchase of clay works of their own. The acquisition of the clay companies explains the recent resignation of Mr. John Hooper, who was responsible for their original development, and has for many years been manager. His son, Mr. Joseph Hooper, will continue as works manager. It is stated that the capacity of the works is 50,000 tons per annum, and that the Paper Makers' Importing Co. intends to push forward development operations, and to this end will install new and up-to-date plant.

St. Austell Estate Owner's Death

A cable has been received at St. Austell that Mr. A. S. G. Carlyon, the owner of Tregrehan Estate, has passed away in New Zealand. Tregrehan Estate includes Holmbush, Tregrehan, Boscopa, and Bethel, and extends along the coast as far as Spit. There are China Clay works, tin and copper mine workings within the estate. Tregrehan Park, where the Prime Minister spoke in June, is the centre of the estate, and in the old days was the residence of the Carlyons. Mr. Carlyon was between 65 and 70 years of age, and had only once visited his estate. That was about 30 years ago, when he succeeded to it, and remained about six months. His heir, Major

E. T. R. Carlyon, paid a brief visit in the early days of the War while at Eton. He served in the War and was wounded, losing the sight of one eye.

Mr. A. S. G. Carlyon settled in New Zealand many years ago, and has preferred to continue sheep farming there rather than to manage his estate. This duty devolved in turn upon the late Mr. Edmund Carlyon, the late Mr. John Stephens, and now upon Dr. Newcome Wright, of Stephens, Graham, and Wright and Co. Early this year the estate was formed into a limited liability company. A progressive policy has marked the recent management of the estate, in connection with which Carlyon Bay is being developed.

A Biographical Note

Mr. J. M. Coon, who is well known for his geological work in the China Clay area, is the subject of a biographical note published recently in *The St. Austell Guardian*. The writer of the note says of Mr. Coon that "he probably knows more about the scientific side of China Clay—its geology, formation, composition, and chemistry—than any other man in the St. Austell district. He has made a study of China Clay from the scientific standpoint for a great number of years, and is a recognised authority on the subject. He has examined China Clay, China Stone, and the granite and rock formations of Cornwall in practically every way in which they are capable of being examined scientifically, and has at his home at Mount Charles such a collection of the results of his researches as will not be found elsewhere in the West of England. Besides being a master in the art of analysis—possessing infinite patience in probing the secrets of nature—he possesses the ability to communicate the knowledge so obtained to others. The results of his researches with the aid of the microscope have led to the peculiarities and characteristics of the various quarried products in which Cornwall abounds being understood as they had not been understood before, and have been valuable contributions to the study of petrology. Where other men with superficial knowledge parade it with the confidence of an expert, Mr. Coon possesses the knowledge revealed by intimate personal contact with the materials, and speaks with first-hand information of his subject. He has lectured before all sorts of learned societies, including those connected with the ceramic industry, which is so practically interested in Cornwall's staple products.

"Like most scientific men, Mr. Coon is a retiring, unobtrusive, modest individual, shrinking from publicity and only coming out when pressed to do so. He prefers to entertain persons who are interested at his home, and there to show and explain to them in an informal way the results of his work. He has conducted his researches for the pure joy of the quest for knowledge, and not from any desire for personal gain. Had he set out to profit to the extent he might have done from the researches he has made, he might have amassed much money. The China Clay industry owes a good deal to the light he has brought to bear upon the scientific and technical sides of the product. If and when there is set up in connection with the industry a laboratory where investigations can be carried out on a large scale for the benefit of the China Clay industry as a whole, as distinct from individual firms, it will have in Mr. Coon a man ready and capable of conducting it. Under the working of the Association method of carrying on the industry, recently revived, an almost insurmountable difficulty has been to find a sampling medium acceptable and satisfactory to everybody. When the Association is setting up its new sampling organisation, it might do a great deal worse than enlist the services of Mr. Joseph Coon. It would be some recompense and recognition for the gratuitous services he has rendered the industry.

"Mr. Joseph Coon is the eldest son of the late Mr. Alexander Coon, who established one of the most successful St. Austell tailoring businesses (now no longer in existence). He is the unwitting disturber of the peace of mind of innumerable citizens. As clerk to the Income Tax Commissioners, a position he has held for a great number of years, his signature is appended to those unwelcome documents that come through the post intimating what the said citizens have been assessed for income tax. Another official position Mr. Coon has held for a great number of years is that of clerk to the St. Austell Market Commissioners."

Shipping and Export News of the Month

We give herewith latest particulars relating to arrivals and sailings of ships engaged in the China Clay trade, at the principal British clay ports. Registered exports of China Clay, with countries of destination, and other shipping and export matters are dealt with.

Fowey Shipping—August, 1927

Arrived.	Name.	Sailed.	Destination.
August 1, s.s.	<i>Pamela</i>	August 4, Tayport	
August 2, s.s.	<i>Cairnhill</i>	August 9, Portland, Me.	
August 2, s.s.	<i>Pansy</i>	August 3, Leith	
August 2, s.s.	<i>Southwell</i>	August 5, Rouen	
August 4, s.s.	<i>Moss Rose</i>	August 6, Runcorn	
August 4, s.s.	<i>Pylades</i>	August 9, Antwerp	
August 5, s.s.	<i>Horn</i>	August 9, Santander	
August 5, s.s.	<i>P.L.M. 27</i>	*	*
August 5, m.v.	<i>Lydia Cardell</i>	August 10, Rouen	
August 5, s.s.	<i>Mersey</i>	August 6, Ridham	
August 5, s.s.	<i>Blush Rose</i>	August 10, Weston Point	
August 5, s.v.	<i>Flying Foam</i>	August 10, Mevagissey and Par	
August 5, m.v.	<i>Marcie</i>	August 10, Harburg	
August 5, s.s.	<i>Ardgantock</i>	August 11, Brussels	
August 6, s.s.	<i>Glenshesh</i>	August 10, Par	
August 6, s.s.	<i>Adour</i>	August 12, Antwerp	
August 7, s.s.	<i>Ferrum</i>	August 10, Runcorn	
August 7, s.s.	<i>Bracondale</i>	August 12, Norfolk, Va.	
August 7, s.s.	<i>Hampshire Coast</i>	August 11, Liverpool	
August 8, m.v.	<i>Hope</i>	August 11, Pentewan	
August 8, s.s.	<i>Gouwestroom</i>	August 12, Amsterdam	
August 11, s.s.	<i>Brier Rose</i>	August 13, Preston	
August 11, m.v.	<i>Wirumaa</i>	August 11, London	
August 11, s.s.	<i>Afon Dyfi</i>	August 13, Antwerp	
August 12, s.v.	<i>Pedestrian</i>	August 23, Weston Point	
August 12, m.v.	<i>Hope</i>	August 14, Torquay	
August 13, m.v.	<i>Mayblossom</i>	August 14, Par	
August 14, s.s.	<i>Mons</i>	August 18, Karlskrona	
August 14, s.s.	<i>Primrose</i>	August 22, Preston	
August 17, s.s.	<i>Farfield</i>	August 23, Antwerp	
August 17, s.v.	<i>W. E. Gladstone</i>	August 24, Plymouth	
August 17, s.s.	<i>Hayle</i>	August 22, Manchester	
August 17, s.s.	<i>Cornish Merchant</i>	August 22, Rouen	
August 18, s.s.	<i>Guelder Rose</i>	August 23, Weston Point	
August 18, s.s.	<i>Suffolk Coast</i>	August 19, Liverpool	
August 18, s.s.	<i>Endymion</i>	August 22, Hamburg	
August 18, s.v.	<i>Waterwitch</i>	August 30, Grimsby	
August 19, s.s.	<i>Brier Rose</i>	August 24, Weston Point	
August 19, s.v.	<i>Duchess</i>	August 28, Liverpool	
August 19, s.s.	<i>Reedness</i>	August 23, Antwerp	
August 20, s.s.	<i>Mersey</i>	August 23, Ridham	
August 20, s.v.	<i>Lady Agnes</i>	* Runcorn	
August 20, s.s.	<i>Maria</i>	August 24, Stettin	
August 20, s.s.	<i>Pet</i>	August 23, Par	
August 20, s.s.	<i>Gouwestroom</i>	August 24, Amsterdam	
August 22, s.s.	<i>Ravenspoint</i>	August 25, Genoa	
August 24, s.s.	<i>Blush Rose</i>	August 25, Preston	
August 24, s.s.	<i>Glenshesh</i>	August 25, Harburg	
August 24, s.s.	<i>Dunmore</i>	August 26, Runcorn	
August 24, m.v.	<i>Henford</i>	* Rouen	
August 24, s.s.	<i>Afon Dulais</i>	August 27, Antwerp	
August 25, s.s.	<i>England Maru</i>	* Portland, Me.	
August 25, s.v.	<i>Dispatch</i>	* Glasgow	
August 25, s.s.	<i>Ardgarrock</i>	August 31, Brussels	
August 25, m.v.	<i>Kathe Jurgenson</i>	Sept. 1, Reval	
August 25, s.s.	<i>Moss Rose</i>	August 27, Garston	
August 26, s.s.	<i>Tanny</i>	August 26, Bristol	
August 26, m.v.	<i>Dankward</i>	August 31, Bremen	
August 28, s.s.	<i>Gower Coast</i>	August 31, Liverpool	
August 29, s.s.	<i>Estella</i>	Sept. 1, Pasages	
August 29, s.s.	<i>Trevallas</i>	August 29, Polperro	
August 30, m.v.	<i>A. H. Both</i>	* Riga	
August 30, s.s.	<i>Abercraig</i>	Sept. 1, Barry	
August 30, s.s.	<i>Wearbridge</i>	* Philadelphia	
August 30, s.s.	<i>Wenchita</i>	* Montreal	
August 30, m.v.	<i>Kongedybet</i>	* Odense	
August 30, s.s.	<i>Dunvegan</i>	* Weston Point	
August 31, s.s.	<i>Primrose</i>	* Weston Point	
August 31, s.s.	<i>Mariska</i>	* Genoa	

* Signifies "In Port."

Charlestown Shipping—August, 1927

Date.	Vessel.	Destination.
August 4	<i>Wellington</i>	Goole
August 10	<i>Millocrat</i>	Liverpool
August 11	<i>Brooklands</i>	Aberdeen
August 12	<i>Mary B. Michell</i>	Rochester
August 12	<i>Englishman</i>	Runcorn
August 16	<i>Aspen</i>	Preston
August 18	<i>Mary Ann Mandell</i>	Runcorn
August 19	<i>Jolly Marie</i>	Gravesend
August 24	<i>System</i>	Aberdeen
August 29	<i>Alert</i>	Weston Point
August 31	<i>St. Brandon</i>	Preston

Par Harbour Shipping—August, 1927

Date.	Vessel.	From
August 2, s.s.	<i>Moss Rose</i>	Garston
August 3, s.s.	<i>Ebbrix</i>	Teignmouth
August 3, s.v.	<i>Leading Light</i>	Salcombe
August 4, s.v.	<i>Daisy</i>	Falmouth
August 5, m.v.	<i>Shortest Day</i>	Plymouth
August 5, m.v.	<i>Grit</i>	Exmouth
August 6, s.s.	<i>Ewy</i>	Bridport
August 10, s.v.	<i>Pearl</i>	Falmouth
August 10, s.s.	<i>Glenshesh</i>	Fowey
August 11, m.v.	<i>Capable</i>	Dartmouth
August 12, s.v.	<i>Flying Foam</i>	Mevagissey
August 13, s.s.	<i>Grosvenor</i>	Plymouth
August 14, s.s.	<i>Wheatvale</i>	Falmouth
August 16, s.v.	<i>May Blossom</i>	Fowey
August 17, s.s.	<i>Treleigh</i>	Portreath
August 17, s.s.	<i>Letty</i>	Newport
August 19, s.s.	<i>Robrix</i>	Kingsbridge
August 21, s.v.	<i>Hero</i>	Falmouth
August 23, s.v.	<i>Pet</i>	Fowey
August 25, s.s.	<i>Amy Summerfield</i>	Plymouth
August 26, m.v.	<i>Isabel</i>	Salcombe
August 26, m.v.	<i>Heather Pet</i>	London
August 26, m.v.	<i>Rochester Castle</i>	London
August 27, s.s.	<i>Lady Belle</i>	Plymouth
August 27, s.s.	<i>Branksea</i>	Weymouth
August 27, s.s.	<i>Eastoft</i>	Blyth
August 28, s.v.	<i>John Sims</i>	Weymouth
August 28, s.s.	<i>Stanwell</i>	Newport
August 29, s.s.	<i>Glenbrook</i>	Treport
August 30, m.v.	<i>Isabel</i>	Falmouth
August 30, s.s.	<i>Winifred</i>	Truro

Date.	Vessel.	Destination.
August 2, s.s.	<i>Southwell</i>	Fowey
August 3, s.v.	<i>Rothersand</i>	Weston Point
August 3, m.v.	<i>Lee Lee</i>	London
August 4, s.s.	<i>Moss Rose</i>	Fowey
August 4, s.s.	<i>Ebbrix</i>	Dover
August 5, m.v.	<i>Hela Naval</i>	Fowey
August 6, m.v.	<i>Grit</i>	Rochester
August 11, s.v.	<i>Leading Light</i>	Gravellines
August 11, s.s.	<i>Ewy</i>	Fredrikshall
August 12, m.v.	<i>Capable</i>	Rochester
August 13, s.s.	<i>Glenshesh</i>	Preston
August 14, s.v.	<i>Daisy</i>	Weston Point
August 14, s.v.	<i>Pearl</i>	Runcorn
August 15, s.s.	<i>Grosvenor</i>	Lancaster
August 16, m.v.	<i>Shortest Day</i>	Plymouth
August 16, s.s.	<i>Wheatvale</i>	Larne
August 18, s.v.	<i>May Blossom</i>	Plymouth
August 18, s.v.	<i>Flying Foam</i>	London
August 18, s.s.	<i>Treleigh</i>	Preston
August 18, s.s.	<i>Letty</i>	Penryn
August 19, s.s.	<i>Robrix</i>	Gravesend
August 26, m.v.	<i>Isabel</i>	Pentewan
August 27, s.s.	<i>Amy Summerfield</i>	Preston
August 29, s.v.	<i>Hero</i>	Runcorn
August 29, s.v.	<i>Pet</i>	Weston Point
August 30, m.v.	<i>Heather Pet</i>	Rochester
August 30, s.s.	<i>Glenbrook</i>	Gravellines
August 31, s.s.	<i>Branksea</i>	Terneuzen

Par Harbour Tide Table, October, 1927

(British Summer Time Throughout.)

Day of Week.	Day of Month.	Morning.	Afternoon.	Height.
Saturday	1	9.4	9.19	11.6
Sunday	2	9.35	9.53	10.10
Monday	3	10.13	10.36	10.1
Tuesday	4	11.3	11.36	9.5
Wednesday	5	—	0.16	9.1
Thursday	6	1.3	1.51	9.6
Friday	7	2.36	3.16	10.6
Saturday	8	3.51	4.21	11.10
Sunday	9	4.47	5.11	13.0
Monday	10	5.34	5.56	13.11
Tuesday	11	6.18	7.40	14.3
Wednesday	12	7.2	7.24	14.7
Thursday	13	7.45	8.5	14.6
Friday	14	8.25	8.46	13.10
Saturday	15	9.6	9.27	12.10
Sunday	16	9.48	10.11	11.8
Monday	17	10.37	11.7	10.6
Tuesday	18	11.43	—	9.6
Wednesday	19	0.26	1.13	9.4
Thursday	20	2.0	2.43	9.10
Friday	21	3.21	3.54	10.7
Saturday	22	4.21	4.44	11.5
Sunday	23	5.4	5.23	12.0
Monday	24	5.41	5.58	12.5
Tuesday	25	6.14	6.29	12.8
Wednesday	26	6.43	6.58	12.9
Thursday	27	7.12	7.26	12.9
Friday	28	7.41	7.55	12.6
Saturday	29	8.9	8.24	12.1
Sunday	30	8.39	8.55	11.7
Monday	31	9.12	9.30	10.11

E. CLEMENS, Harbour Master.

China Clay Exports for August

A RETURN showing the exports of China Clay, the produce of the United Kingdom, from the United Kingdom to each country of destination as registered during the month ended August 31, 1927:—

COUNTRY OF DESTINATION.	QUANTITY		VALUE.
	Tons.	£	
Finland	257	210	
Sweden	1,290	2,765	
Norway	1,423	2,878	
Denmark	648	840	
Germany	2,998	6,402	
Netherlands	4,556	9,904	
Belgium	4,954	8,925	
France	4,185	7,841	
Portugal	20	37	
Spain	784	1,396	
Canary Islands	200	540	
Czecho-Slovakia	1	5	
Egypt	10	46	
United States of America	37,881	77,888	
Mexico	81	343	
Colombia	—	2	
Cape of Good Hope	24	56	
Bombay, via other Ports	269	1,109	
Bengal	155	364	
Australia	39	166	
New Zealand	1	11	
Canada	59	278	
Irish Free State	452	995	
Total	60,287	123,001	

China Clay Imports for August

A RETURN showing the registered imports of China Clay (including China Stone) into Great Britain and Northern Ireland from the several countries of consignment during the month of August, 1927:—

COUNTRIES WHENCE CONSIGNED.	QUANTITY		VALUE.
	Tons.	£	
Czecho-Slovakia	10	31	
U.S. America	1	16	
Channel Islands	150	280	
Total	161	327	

August Deliveries

As usual in August the deliveries in all classes were down on July, the fall amounting to 20,000 tons. The result is that the total tonnage for the eight months this year has fallen below the tonnage for the corresponding period last year. Though the drop is only 5,000 tons, it is not a pleasing feature to record, seeing that last year the industry laboured under the disadvantages of the coal strike. September is showing a brisker trade and is expected to make up some of the leeway lost in August, which is always a slack month on account of the holidays.

Port.	CHINA CLAY.		CHINA STONE.		BALL CLAY.		TOTAL.	
	1927.	1926.	1927.	1926.	1927.	1926.	1927.	1926.
Fowey	44,137	56,291	4,218	1,991	721	3,518	49,076	61,800
Par	5,484	3,168	534	390	—	—	6,018	3,548
Charlestown	2,027	3,167	—	—	—	—	2,027	3,167
Plymouth	1,630	501	—	—	—	—	1,630	501
Penzance	620	1,132	—	—	—	—	620	1,132
Falmouth	160	100	—	—	—	—	160	100
Looe	162	—	—	—	—	—	162	—
By rail	3,313	2,887	—	—	—	—	3,313	2,887
August	58,433	67,246	4,752	2,381	721	3,518	63,906	73,135
7 months	511,677	521,079	34,993	24,405	14,941	11,609	561,611	557,093
8 months	570,110	588,325	39,745	26,786	15,662	15,127	625,517	629,980

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

London Gazette, &c.**Companies Winding Up Voluntarily**

COLNE BRICK AND TERRA COTTA CO., LTD. F. J. Carpenter, Chartered Accountant, 23, Queen Victoria Street, London, E.C.4, appointed as liquidator, August 24.
MILLBROOK BRICK AND TILE CO., LTD. By special resolution, August 12th, confirmed August 29. E. A. Browne and F. H. Parrott, 4, Southampton Row, Kingsway, London, W.C.1, Chartered Accountants, appointed as liquidators.
SCUNTHORPE SILICA BRICK CO., LTD. B. Spooner, Holder Chambers, 118, High Street, Scunthorpe, Chartered Accountant, appointed as liquidator, August 6.

Mortgages and Charges

[NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]

BURTON BRICK CO., LTD., London, S.W. Registered August 18, £2,000 2nd debenture, to F. H. Benton, 22, Russell Square, Brighton; charged on Burton Brick Works, Burton, Pedwardine, also general charge.

GAVERIGAN CHINA CLAY AND TIN ESTATES, LTD., London, E.C. Registered August 4, debenture securing moneys expended by the mortgagees, River Para Development Syndicate, Ltd., 123-4, Minorities, E.C., in accordance with a certain agreement; general charge. *Nil. December 31, 1926.

SKEGNESS BRICK AND TILE CO., LTD.—Registered August 5, £300 debentures, part £1,000; general charge. *£3,450. May 8, 1926.

SPICERS, LTD. (late SPICER BROTHERS, LTD.), London, E.C., paper manufacturers. Registered July 29 (by order on terms), £6,350 mortgage dated December 29, 1913, to R. A. Molesworth, Mittagong, Grey Street, St. Kilda, Australia; charged on land at Flinders Lane, Melbourne; also registered July 29 (by order on terms), extension of mortgage securing increase in rate of interest on £5,000 outstanding, to National Mutual Life Association of Australasia, Ltd., Melbourne; charged on Town Lots 374 and 375, Flinders Lane, Fremantle. *£165,952 is. 8d. June 25, 1926.

TAMS (JOHN) LTD., Longton, earthenware manufacturers. Registered July 28, £3,000 debentures; general charge. *£5,000. March 26, 1927.

Satisfaction

GIBBS AND CANNING, LTD., Tamworth, brick, etc., manufacturers. Satisfaction registered August 19, £4,000, registered June 18, 1907.

The China Clay Trade Review

The Official Organ of the China Clay Industry and the only Journal specially devoted to its interests.
Published in the third issue of "The Chemical Age" each month.

All Editorial communications should be addressed to the Editor, "The China Clay Trade Review," Benn Brothers, Ltd., Bouverie House, 154, Fleet Street, E.C.4. All communications relating to Advertisements, Subscriptions, etc., should be sent to the Manager, "The China Clay Trade Review," at this address. Telegrams—"Allangas, Fleet, London." Telephone—City 0244 (10 lines).

China Clay Prices

Rather earlier than this time of the year, the China Clay producers periodically go into the question of prices, in order to be in a position to arrange contracts for the following year at the prices so arrived at. Since the old China Clay Association broke up there has been, as a result of experience gained through the low pricing of clays by individual firms which followed the collapse of the old Association, a gradual hardening of prices to bring them more into conformity with real values and to ensure for the firms producing the clays something approximating to a fair return on their capital outlay.

Best clay producers have been able long since so to adjust their prices as to ensure a reasonable profit, on account of the fact that the demand for the very best clays is always keen, and therefore makes it possible for producers of such clays to look adequately after their own interests. But with the producers of common clays this has not been the case since the old Association broke up, and inasmuch as producers of best clays, who also produce common clays, have been able to work one against the other to the advantage of both qualities, the producers of common clays only have had to submit to the vagaries of the market and to the price-cutting of competitors, with the result that several of them have found themselves in a by no means enviable position financially.

Better Prices Justified

We referred just now to the tendency there has been in the last year or two for prices to harden through producers finding themselves unable to make both ends meet at the low prices that have been operating. Whether or not there had this year been a new organisation set up by the China Clay producers, there was a disposition on the part of individual firms to advance prices for next year. It is only natural that there should be a certain amount of concern and protest raised against the prices so far fixed for next year, but any wholesale condemnation of them, especially from middlemen, is not justified when they bear in mind what a good time they have had in the last few years in obtaining their supplies at such a low figure. Such low prices have been ruling not in order to enable certain producers to undersell in order to secure certain markets, but to protect their existing markets against the price-cutting of competitors.

It has been suggested more than once that home producers of China Clay have sold their clays at low prices in order to undersell the American domestic clay market. Such has never been the object of the producers over here, and now that they are taking steps to ensure that their clays shall not be sold at a figure below their intrinsic value, it would hardly be cricket for buyers, whether they be middlemen or consumers, to kick against such prices as the trade as a whole have come to the conclusion should be charged.

Users Can Stand Them

As regards the argument so often used that the trade will suffer because the consumers are not in a position to pay the increased prices, it must be borne in mind that the proportion of China Clay used in paper making, pottery, and

bleaching represents a comparatively small proportion of the ultimate cost of these manufactures, so that every shilling per ton by which prices of China Clay are advanced will mean a very small fraction of additional cost of the manufactures in which China Clay is used, while the consequent lessening of the profits derived from such manufactures would be so infinitesimal as to be negligible. From the records of the profits made by users of China Clay, and from the opinions expressed by those in intimate touch with such firms, there is little doubt that they can bear a little additional increase in the price of one of the cheapest raw materials they can use. This little difference in the cost may be the means of restoring prosperity to the China Clay industry, and ensuring a fair return to the shareholders in it, as well as putting them in a position to employ more labour, which, for the last two or three years, has been down to the lowest possible limit.

Drastic revision of prices as regards China Clay is long overdue, and buyers can count themselves fortunate that they have been able to purchase their supplies at such a low figure, which has been, however, at the expense of an industry which is entitled to a fair recompense for the time, energy, and capital involved.

Trade Unionism in the Clay District

Little objection will be taken by those who value trade unionism to Mr. Joe Harris's campaign for bringing the China Clay workers back to the fold. The China Clay proprietors certainly have no desire to disparage his efforts, for they have long since recognised the trade union system as applied to the clay workers, having a parallel organisation in the Employers' Federation to serve as the mouth-piece of the China Clay proprietors.

When Mr. Harris referred to the effects of the association system as applied to the industry, he was somewhat obscure. He seemed to suggest that an association such as the industry used to have benefited only the China Clay proprietors. As a matter of fact, the industry never employed more labour or disbursed larger sums in wages than it did when the old association was in being, for then the better prices obtainable for clays enabled the industry to employ a much larger number of men, and when men normally employed on production became surplus they were transferred to development work rather than thrown on the unemployment market. When prices are cut to the barest margin, the inevitable consequence is a cutting down of costs to the barest limits, hence the absence of a margin for the continued employment of surplus labour.

The men need not fear that the buying up of China Clay works by foreign countries will be extensively followed. It was the absence of an association on the old lines and not the influence of an existing one that was a factor which led an American firm to acquire a couple of clay works recently, to enable it to ensure a supply of best clay for its own customers. It is the pressure of economic law that has led to the reduction of labour and labour costs to the present level in the China Clay works, and to rectify that pressure scientifically through the setting up of associations has proved to be to the advantage of the China Clay workers as well as to the employers, and will again.

The Clay Convention **A Successful Meeting**

At the biennial convention of the clay industry and its allied trades in Great Britain, at Bournemouth recently, there was a representative gathering of clay proprietors from all parts of the country. The visitors included not only manufacturers of refractory materials but also of bricks, roofing tiles, glazed bricks, sanitary ware and pipes, terra-cotta, silica goods, etc. The visit of the Convention to Bournemouth was a particularly appropriate one, for in the neighbouring borough of Poole and the surrounding district clay production is the chief industry. It is a coincidence also that the Mayor of Poole, Alderman H. S. Carter, J.P., is a member of a well-known pottery firm, whilst the Mayor of Bournemouth, Alderman H. J. Thwaites, is a retailer of china and glass ware.

The local arrangements were in the able hands of a committee consisting of the Mayor of Poole (Kinson Pottery, Ltd.), Mr. Cyril Carter (Carter and Co.), Major F. G. P. Gedge and Mr. A. M. Bolton (Sharp, Jones and Co.), and Mr. A. B. Crawshaw (Geo. Jennings and Co.). The Convention secretary was Mr. H. Halliday, who was most assiduous and helpful in carrying out the general arrangements.

Interesting Topics at the Conference

Mr. H. J. C. Johnston, the president, was in the chair when a general conference of members of all branches of the trade was held, and various subjects were discussed, following the president's address and a vote of thanks to the Mayor and Corporation and the local committee.

Mr. E. Gwynne Vevers, proposing thanks to the Bournemouth Corporation, said that when the Convention officials approached the civic authorities they received every encouragement to go forward, and were promised every possible help to make the Convention successful. He thought that with the aid of the Corporation and the president the Convention had been a happy and useful one. The numbers attending showed that members had not been deterred from coming by the distance. Following the president's address on the subject of "Pride in Industry," Alderman H. S. Carter, J.P., gave an address on local clay products. "Poole," said Alderman Carter, "had its clay pits and its pottery before Hanley was dreamt of as a pottery centre, and the varied products which have been wrought from our clay since the pre-Roman craftsmen turned out pots suggest a pretty wide range." In proof of this the speaker referred to the finds of Roman and pre-Roman date by Mr. H. P. Smith of Poole.

Referring to the local clay and its manufacture, he said that in Poole they had a conceit that it was only from Poole clays that real acid-proof non-porous stoneware could be made. He referred in this connection to the local manufacture of drainpipes and fittings and to the output of concrete tubes, which latter was still regarded in some quarters as a worship of strange gods.

Artistic and Other Bricks

Most of the local manufacturers, however, made bricks as a side line, and hand-made bricks of some artistic merit were also a feature of their trade. He thought that all would agree that if only the public would insist on something a little more sightly than the monotonous machine-made bricks for their dwellings, the appearance of our fast-growing towns would be vastly improved. The making of hand-made bricks was, he feared, almost a lost art. But nothing could save it except a renewed demand. One of the glories of the old town of Poole was the beautiful brickwork to be seen in the mansions built over a century ago by Newfoundland traders who grew rich in their adventuring.

Referring to stoneware pottery and tiles, Alderman Carter said the latter were ridiculously expensive. Although Poole seemed rather far removed from the centre of the pottery world, he thought that in the matter of tiles, faience, terra-cotta, and pots, Poole sent out goods worthy of finding their way round the world and of holding their own in the world's markets.

Export of Ball Clays

Dealing with the export of Poole clays (which are similar to the Ball Clays of Devon), he said that they went to all parts of Europe, and deft hands and deft machines moulded them tenderly into a fine or useful form in a thousand varieties.

Possibly on the heathlands which covered the rich deposits of clay in the Poole district there might be room for more potteries; great industries might in years to come spread further the good name of Poole pottery; and some of those present, impressed by the possibilities and the genial air of Dorset, might themselves place their capital upon such adventures. "But for goodness sake," said Alderman Carter, "have a little originality, and don't think of stoneware drainpipes!"

Following this speech there were discussions on technical subjects, as follows: "Themes for Clayworkers"; "If you don't see it in the window . . ."; "A new type of gas-fired tunnel kiln, etc."; "The right and wrong uses of bricks and terra-cotta from the architect's point of view." In the evening the Convention banquet was held at the Town Hall, the Mayor (Alderman H. J. Thwaites) the Rt. Hon. Sir Hamar Greenwood, M.P., and Mr. G. R. Hall Caine, M.P., being among the guests.

China Clay as a Material

Wide Variation in Uses and Applications

UNDER the general title of Benn's Sixpenny Library, the firm of Ernest Benn, Ltd., is providing a series of monographs on science, art, literature, etc., by leading authorities, at the standard price of sixpence per volume. No. 177 of the series, entitled "Trade," is written by Sir Ernest J. P. Benn, chairman of the company. In exemplifying the strange disguises and changes undergone by a single substance in its transformation from the crude material to the finished product, he gives the following account of China Clay:—

"A useful piece of educational work in connection with trade might be done by some genius who would devise a new form of game, a sort of crossword puzzle, which would place upon the competitor the task of tracing some little morsel of raw material round the world, the winner in such a game to be the player who succeeded in making the longest journey, or who managed to bring the material back home after the most varied experiences. In these days of 'Mustard Clubs' and 'Frothblowers' it would not, for instance, be unreasonable to suggest to the China Clay trade that a subtle propaganda could be devised for their benefit. China Clay, of which Cornwall enjoys something very near to a monopoly, enters into the manufacture of a large variety of things. It is the basis of some sorts of toilet preparations; it is used by toilet soap-makers; the best class of paper depends upon China Clay for its surface; medicine-makers use a good deal as a foundation for ointments; while, of course, its chief use is in the manufacture of chinaware itself.

"The game that I would propose would divide up a load of China Clay at the quarries in Cornwall; would send some of it to America for the toilet preparation manufacturers; some more to Gravesend to a paper mill; and the rest to Sèvres for the pottery kilns. These parcels would then be traced back through shippers and importers and wholesale and distributing chemists; through paper-warehouses; through pottery manufacturers who had produced dainty ornaments for a lady's dressing table; and at the end of the game, the winner would show how a teaspoonful of common raw material from Cornwall had been split up and wandered about the world, and had come back to the boudoir of the Cornish lady disguised as a pot of face-cream wrapped in a most artistic paper covering. Complications would be introduced for skilled players, as, for example, if the China Clay which went to Gravesend were first made into high-grade art paper for one of the expensive magazines, and, having fulfilled its mission in this respect, had been repulped in some other part of the country to form the foundation of a coarser paper for packing."

Cornwall's Rain Record

THE surveyor of the St. Austell Urban Council has reported a big increase in the gaugings of the springs as a result of the wet season. In July the rainfall was 3.57 in., against 1.4 in. in July last year; and in August 4.56 in., against 2.23 in. The total rainfall this year to date was 38.4 in., against 25.5 in. for the corresponding period last year, and exceeded the total for the whole of last year.

Fuel Costs in Refractories

Results of Investigation

SUBSTANTIAL economies in the operation of plants manufacturing refractories, with improvement in the quality of the wares produced, were effected as the result of a series of firing tests conducted by engineers of the United States Bureau of Mines, Department of Commerce, at seven large establishments of this character. The plants visited by the Bureau of Mines engineers included magnesite-brick, silica-brick, and fireclay-brick plants located in various eastern States. The specially equipped laboratory car "Holmes," was used in the investigation. Changes made by the engineers in the operation of the kilns resulted in reducing the time of burning and the clay consumption at most of the plants visited, and in some cases resulted in a better burning which gave a large percentage of first-quality brick.

This investigation was conducted in co-operation with a technical committee, selected by the Refractories Manufacturers' Association. In large measure the work was an outgrowth of a previous investigation of burning problems conducted by the Bureau of Mines for the Four Heavy Clay Products Associations. The investigation had as its aim to increase the efficiency of burning conditions in the particular plants where the tests were run, and to obtain data that would be of general value to the refractories industry. Aside from the problems inherent in the burning of different kinds of ware in different kilns, many of the plants presented special problems.

Object of Investigation

The three main objects, so far as each plant was concerned, were: Production of better ware, conservation of fuel, and increased kiln turnover.

Some problems of general interest upon which special data were gathered are as follows:

- Heat distribution, including a temperature survey and draft survey.
- Proper proportions of kiln.
- Manner of setting ware to obtain best distribution of heat.
- Open against closed firing.
- Progress of combustion in kilns.
- Induced against natural draught.
- Smoke prevention.
- Laboratory control of firing practice.
- Oxidation of sulphur.
- Equipment for high-temperature measurements.

In general, the work consisted in making two consecutive tests with the same kiln. For the first test the kiln was set and fired according to regular factory practice, data were taken, and a careful study was made of the burning conditions. While the kiln was being cooled and drawn, the results and data obtained were tabulated and plotted. For the second tests, such changes were made in the kiln proportions, setting and firing, as a study of the data and considerations of economy warranted. The average factory data on burning, such as period of burning, quantity of fuel used, and quality of product, were obtained from the plant superintendent. By comparing the results of the first and second tests with the average factory practice, the results from changes made could be determined.

At the seven plants where the tests were made the reduction in time of burning was, in the order of the investigations, 0.3 per cent., 35 per cent., 21.7 per cent., 13.7 per cent., 32.8 per cent., 26.9 per cent., and 2.4 per cent., an average of 19 per cent. In the same order, the fuel consumption was 4.5 per cent. less, 43 per cent. less, 11.2 per cent. more, 5.6 per cent. less, 30.5 per cent. less, 11.2 per cent. less, and 10.8 per cent. less—an average saving in fuel of 13.5 per cent. In half the plants the quality of the ware improved.

The total fuel consumption in burning magnesite brick in the round down-draft kiln with boxing of silica brick amounted to 68.9 per cent. of the weight of the brick fired; of silica brick, 68.2 per cent.; and of fireclay brick, 20.7 per cent. It is reported that in Europe fireclay brick is fired to cone 12 in various types of regenerative kilns with 8 per cent. of fuel, which points to the possibility of great fuel savings with the installation of such equipment. Proper structure in a refractory can, however, only be attained by prolonged soaking at the maturing temperature, and large shapes require more time than does smaller ware.

The results of this investigation are contained in Bureau of Mines Bulletin 271, "Problems in the Firing of Refractories," by G. A. Bole, John Blizard, W. E. Rice, E. P. Ogden, and R. A. Sherman. Copies of this bulletin may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C., at a price of 50 cents.

U.S. Production of Clay, 1926

Official Figures

THE quantity of clay sold by producers in the United States in 1926 amounted to 3,966,313 short tons, valued at \$14,102,505, or \$3.56 a ton, according to a statement made public by the Bureau of Mines, Department of Commerce. These figures show a decrease of 2 per cent. in quantity and an increase of 11 per cent. in value compared with 1925. They represent only clay sold as clay or mined under royalty and do not include the much greater quantity of clay that was burned into clay products by the producers themselves from their own property. The data were collected direct from producers in 43 States and in co-operation with the State Geological Surveys. The leading five States in the order of the quantity of clay sold were: Pennsylvania with 22.6 per cent. of the total quantity, Missouri with 11.6 per cent., New Jersey with 8.6 per cent., Ohio with 8.5 per cent., and California with 7.5 per cent.

The sales of kaolin, the clay that is used in making high-grade pottery and porcelain, as well as paper, oilcloth, and other products, and which is generally considered the highest grade of clay, amounted to 432,215 tons, valued at \$3,771,568, an increase of 18 per cent. in quantity and 17 per cent. in value as compared with 1925. The clay of largest quantity and value is fire clay. The sales of fire clay in 1926 were the largest ever recorded—2,815,961 tons—and were 10 per cent. greater than those of 1925, the year of largest output previous to 1926. The value of the fire clay sold in 1926 was \$8,111,239, an increase of 11 per cent. as compared with 1925. The sales of clay of every kind, except miscellaneous clay, increased in quantity and value in 1926 as compared with 1925.

The imports and exports of clay increased in quantity and value in 1926 as compared with 1925. The imports of clay amounted to 489,670 short tons, valued at \$4,247,911, an increase of 12 per cent. in quantity and 11 per cent. in value. Exports of clay in 1926 amounted to 89,894 tons, valued at \$992,718, an increase of 8 per cent. in quantity and 13 per cent. in value as compared with 1925. Kaolin, or China Clay, constituted 81 per cent. of the total imports in 1926. Fire clay, the principal clay exported, amounted to 53 per cent. of the total.

CLAY SOLD BY PRODUCERS IN THE UNITED STATES IN 1925 AND 1926.

Kind	1925		1926	
	Short Tons	Value \$	Short tons	Value \$
Kaolin	367,319	3,220,719	432,215	3,771,568
Ball Clay	109,607	699,427	112,193	867,500
Slip clay	7,349	37,397	8,644	45,959
Fire clay	2,566,934	7,312,349	2,815,961	8,111,239
Stoneware clay	77,438	162,161	82,476	182,236
Miscellaneous	901,773	1,304,579	514,822	1,124,003
	4,030,420	12,736,632	3,966,313	14,102,505

China Clay in Yugoslavia

THE Union of Croatian and Slavonian merchants of Zagreb, in a petition addressed to the General Customs Control in Belgrade, has put forward a request for the introduction of a protective duty on China Clay. At present Yugoslavia's requirements in China Clay are covered by supplies from Hungary and Czechoslovakia, and these enter the country free of duty. It is pointed out in the petition that the reason why the 500 wagon loads, which represent the yearly requirements, are only drawn from outside the country is because it is not known in interested circles that Yugoslavia disposes of such enormous quantities of China Clay. This China Clay is chiefly found in Serbia (Ub and Kumanova), in Bosnia (near Sarajevo), in the whole of Slovenia, in Slavonia (near Brod, on the Save), and in Croatia (in the district of Beslinac, the former military frontier). Attempts to export China Clay have already (it is said) been successful, and great interest has been shown in Austria as well as Italy in this clay.

China Clay Notes and News

G.W.R. New Goods Station

At the last meeting of the St. Austell Urban Council, the chairman reported upon the interview he and other members of the deputation from the Urban and Rural Councils had had with the G.W.R. officials at Plymouth, with reference to the provision contemplated for dealing with goods traffic at the new goods station proposed to be erected between the embankment at Mount Charles and Polkyth. The scheme had not yet been approved by the headquarters at Paddington, but the delegates were informed that adequate provision was being made in the plans they were shown.

Clay Works' Manager's Services Recognised

Mr. W. J. Tonkin, manager of the Great Treverbyn and Ruddle Common China Clay Cos., has recently been appointed a director. In honour of the event Major Sassoon, managing director, entertained Mr. and Mrs. Tonkin and friends to dinner. Major Sassoon spoke in the highest terms of the service that Mr. Tonkin had rendered the companies as manager, and now welcomed him as a fellow member of the board of directors. Mr. Tonkin replied in suitable terms. Captain Goudge, on behalf of the staff, thanked Major Sassoon for the generous manner in which he had recognised Mr. Tonkin's great service to the companies.

Glenboig Union Fire Clay Co.

The profit of the company for the year ended August 31 last, inclusive of £3,653 brought forward, amounted to £20,118. The directors have applied £1,500 to depreciation of plant and machinery and £2,000 to reserve against Imperial taxation, and they recommend a dividend of 10 per cent., less tax, which will absorb £12,000, leaving £4,618 to be carried forward. In their report the directors say that having regard to the prolonged coal stoppage, during which the company's works were closed down, they consider the results quite satisfactory. The profit for the previous year, including £6,417 brought forward, was £28,153, and the dividend was 17½ per cent., less tax.

China Clay Merchant's Son Married

Last month the marriage of Miss S. Macleod, daughter of Dr. and Mrs. Macleod, of Leicester, and Mr. H. W. Pochin, son of Mr. and Mrs. Stanley Pochin, took place at Leicester. Following the ceremony a reception was held, at which Dr. and Mrs. Macleod entertained a large number of relatives and friends of both the bride and the bridegroom. Later in the day Mr. and Mrs. Horace Pochin left for their honeymoon, which is being spent in Paris and Switzerland. The bride and bridegroom were the recipients of a very large number of valuable presents.

The bridegroom is the son of the managing director of the firm of H. D. Pochin and Co., Ltd., chemical manufacturers and proprietors of numerous China Clay and stone quarries in Cornwall. By profession he is an engineer associated with the Standard Engineering Co. Before taking up his career he graduated at the Loughborough Engineering College. Mr. and Mrs. Pochin are taking up their residence in Leicester.

Physico-chemical Properties of Acid Clay

Two Japanese workers, K. Kobayashi and K. Yamamoto, have been working on the physico-chemical properties of acid clays. A summary of the results of the ultramicroscopic observation of these clays appears in the *Journal of the Society of Chemical Industry, Japan*, for July, and the following details are given: Ultramicroscopic photographs of several acid clays, colloidal carbons, silica gels, etc., have been taken by the cardioid ultramicroscope, and the sizes of the particles have been determined by the slit ultramicroscope. The colloidal structure of acid clay has been observed, and some differences have been shown to exist between acid clay and many other clays. It is considered that the acid clay is constituted of very minute particles compared with other clays, and the radius of particles remaining in the solution separated by a centrifugal machine of 4,000 revolutions per minute has been calculated to be between 1×10^{-6} and 2×10^{-5} c.m. Acid clay which has been calcined at 300° C. has shown no perceptible change of structure, but at 500° C. its colloidal structure has disappeared, changing into a transparent rocky appearance.

St. Austell's "G.O.M." Dead

By the death, recently, of Mr. H. Sidney Hancock, at the age of 77, St. Austell has lost one of its most conspicuous figures. He believed in the gospel of work as a factor in the cultivation of a contented mind, and as one of the greatest contributors to human happiness and well-being. The public work of Mr. Sidney Hancock is writ large in the annals of St. Austell for the last 50 years. On his retirement from the St. Austell Urban Council on the extension of the area two and a half years ago, he was St. Austell's oldest local government representative. He was a member of the old Local Board that preceded the Urban Council. In the sphere of education Mr. Hancock's name will ever find a conspicuous place. Under his guidance as clerk to the St. Austell School Board up to 1903, when it was superseded by the County Council, the elementary schools in the St. Austell district had a standard of efficiency that was recognised as the highest in the county.

Professionally, Mr. Hancock was a surveyor, land agent, auctioneer, and architect. He was very familiar with the China Clay district and had surveyed and marked out more clay setts than any other man. Until their sale, several years ago, he was for many years manager of Thriscutt and Bale's Caudletown China Clay Works. His chief hobby may be said to have been the study of the locality from the point of view of the antiquarian. He knew the St. Austell parish better than anyone else, having studied its history, topography, and geology. He leaves two sons (one holding a responsible position at the Admiralty and the other being an engineer in Canada) and a daughter.

In spite of a continuous downpour of rain, there was a very large gathering at the funeral, China Clay interests being largely represented.

Trade Unionism in Clay District

Mr. Joe Harris, the Workers' Union West of England organiser, has made his reappearance in the China Clay district, with the object of reviving interest among the China Clay workers in the Workers' Union. Since the days immediately following the war, when the Union was a big force, interest in it seems to have decreased. Referring to the days of the old clay association, Mr. Harris said it was broken up in consequence of disagreement between the producers, the object of the association being to secure higher prices and bigger profits. Because of that he said Americans had come over here and bought up clay works in order to compete on better terms with our own producers. He went on to suggest that if other countries did this sort of thing to a large extent and competed with the home producers, the clay proprietors would then come to the workers asking them either to accept lower wages or work longer hours. If the workers did not look out and stand together they would find themselves in a worse position than they were. He was always willing to come down and do what he could for the men, but it would be no good him using his strength to help them if the men would not do their part. They were suffering from lack of organisation.

Referring to criticisms that were passed on the expense of the trade unions, he claimed that they were worked far more cheaply than the insurance companies and similar institutions, having regard to the benefits provided and the work done. He urged the clay workers to join up with the Workers' Union, and warned them against having anything to do with the non-political Union that had recently been set up, stating that it had behind it the big industrial concerns.

Mr. Clemens of Liskeard, district organiser of the Workers' Union, also condemned the non-political union. He expressed the hope that Mr. Harris's strength would stand the strain of conducting the campaign in the clay district to get back for the Union the almost 100 per cent. of the clay workers it had had before. In a criticism of the working of the local Unemployment Committee, Mr. Clemens complained that the workers' representatives on the committee were not consulted as they should be. Though they were told they could attend any meeting of the committee, they were not given notice when the meetings were held.

Shipping and Export News of the Month

We give herewith latest particulars relating to arrivals and sailings of ships engaged in the China Clay trade, at the principal British clay ports. Registered exports of China Clay, with countries of destination, and other shipping and export matters are dealt with.

Charlestown Shipping—September, 1927

Arrived		
Date.	Vessel.	From
September 1	S.S. Jolly Norman	Exmouth
September 4	S.V. Anne	Dartmouth
September 5	M.V. Blairy	Falmouth
September 5	M.V. Lee Lee	Plymouth
September 6	Mary B. Mitchell	Plymouth
September 7	S.S. Robrix	Par
September 8	S.S. Marena	Shoreham
September 10	Gertrude May	Truro
September 11	S.S. Royal Firth	Morlaix
September 11	M.V. Marie Schwinge	Exmouth
September 12	M.V. Freda Both	Bridport
September 15	S.S. Abington	Cardiff
September 16	Najaden	Kotka
September 18	Boulonnaise	Gweek
September 20	Emma Ester	Falmouth
September 24	S. F. Pearce	Falmouth
September 25	Emily Warbrick	Falmouth
September 27	S.S. St. Barchan	Penryn
September 28	S.S. Royal Firth	Cowes
September 28	Mouette	Falmouth
September 29	S.S. Robrix	Rouen
September 30	S.S. Jolly Norman	Porthleven

Sailings		
Date.	Vessel.	Destination.
September 1	S.S. Pegrix	Gravesend
September 3	S.S. Jolly Norman	Greenhithe
September 6	M.V. Lee Lee	London
September 8	Mount Blairy	Runcorn
September 8	S.V. Anne	Nantes
September 9	S.S. Robrix	Leith
September 10	Mary B. Mitchell	Runcorn
September 10	S.S. Marena	Antwerp
September 12	M.V. Conrad Luhring	Gothenburg
September 12	Gertrude May	London
September 13	S.S. Royal Firth	Tayport
September 14	M.V. Marie Schwinge	Helsingfors
September 14	M.V. Freda Both	Trangsund
September 15	Helena Anna	Sunderland
September 22	Boulonnaise	Nantes
September 26	Emma Ester	Glasgow
September 27	Emily Warbrick	Rochester
September 27	S. F. Pearce	Erith
September 28	S.S. St. Barchan	Runcorn
September 29	S.S. Royal Firth	Aberdeen
September 29	Najaden	Copenhagen
September 30	S.S. Robrix	Kirkcaldy
September 30	Mouette	Nantes

Par Harbour Shipping—September, 1927

Arrivals		
Date.	Vessel.	From
September 1	S.S. Magrix	Kingsbridge
September 3	S.V. Lady Daphne	Plymouth
September 3	S.V. Rothersand	Port Navis
September 5	S.S. Robrix	Penzance
September 8	M.V. Isabel	Penryn
September 10	S.S. Treue	Refso
September 14	S.S. Solway Firth	Exmouth
September 14	S.V. Wellington	Penzance
September 15	S.S. Grosvenor	Poole
September 15	S.S. Horn	Lake Venern
September 17	S.V. Katie	Newport
September 22	S.S. Alice	Torquay
September 25	S.S. Farfield	Newport
September 26	S.S. Margaret	Rochester
September 27	M.V. Regina	Plymouth
September 27	M.V. Durlstone	Exeter

Sailings		
Date.	Vessel.	Destination.
September 1	S.S. Magrix	Gravesend
September 7	S.S. Robrix	Charlestown
September 8	S.V. Rothersand	Weston Point
September 9	S.V. Lady Daphne	Rochester
September 15	S.S. Grosvenor	Lancaster
September 16	S.S. Treue	Amsterdam
September 16	S.S. Solway Firth	Fowey
September 17	S.V. Wellington	Goole
September 23	S.S. Horn	Fowey

September 24	S.S. Alice	Terneuzen
September 27	S.S. Farfield	Fowey
September 27	S.S. Margaret	Truro
September 28	M.V. Katie	Greenhithe
September 29	M.V. Regina	Plymouth
September 29	M.V. Durlstone	Boulogne

Par Harbour Tide Table, November, 1927

(Greenwich Mean Time Throughout.)

Day of Week.	Day of Month.	Morning.	Afternoon.	Height.
Tuesday	1	8.50	9.13	10.3
Wednesday	2	9.40	10.13	9.8
Thursday	3	10.51	11.36	9.4
Friday	4	—	0.22	9.9
Saturday	5	1.6	1.44	10.8
Sunday	6	2.18	2.49	11.11
Monday	7	3.16	3.41	13.0
Tuesday	8	4.4	4.27	13.10
Wednesday	9	4.50	5.13	14.3
Thursday	10	5.37	6.1	14.4
Friday	11	6.24	6.46	14.2
Saturday	12	7.7	7.28	13.6
Sunday	13	7.49	8.11	12.7
Monday	14	8.34	8.57	11.6
Tuesday	15	9.22	9.50	10.6
Wednesday	16	10.21	10.57	9.9
Thursday	17	11.37	—	9.5
Friday	18	0.19	0.59	9.9
Saturday	19	1.36	2.8	10.4
Sunday	20	2.36	3.1	11.0
Monday	21	3.23	3.43	11.7
Tuesday	22	4.2	4.20	11.0
Wednesday	23	4.38	4.56	12.4
Thursday	24	5.13	5.30	12.5
Friday	25	5.46	6.2	12.5
Saturday	26	6.19	6.35	12.4
Sunday	27	6.51	7.8	12.1
Monday	28	7.25	7.43	11.8
Tuesday	29	8.2	8.21	11.2
Wednesday	30	8.42	9.6	10.9

E. CLEMENS, Harbour Master.

Record September Deliveries

As we anticipated might be the case, the deliveries in all classes of products dealt with by the China Clay industry in September reached a record, when a total of 90,109 tons was despatched. This has again brought the total of this year above the total for the corresponding period last year, the total in favour of this year being over 2,000 tons. Taking the individual classes, the deliveries of China Clay for the nine months are still nearly 13,000 tons below the corresponding nine months of last year, but there has been an increase of 13,000 tons in deliveries of China Stone, and a little over 1,000 tons in the deliveries of Ball Clay. Following are the detailed figures:—

Port.	CHINA CLAY.		CHINA STONE.		BALL CLAY.		TOTAL.	
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
1927.	1926.	1927.	1926.	1927.	1926.	1927.	1926.	1926.
Fowey	66,250	62,305	4,415	3,548	3,172	2,194	73,837	68,047
Charlestown	6,259	4,827	—	—	—	—	6,259	4,827
Par	2,830	4,547	94	—	—	—	2,924	4,547
Penzance	1,468	464	—	—	—	—	1,468	464
Plymouth	1,010	645	—	29	—	—	1,010	674
Falmouth	330	—	—	—	—	120	330	120
By rail	4,081	4,571	—	—	—	—	4,081	4,571
September	82,428	77,359	4,509	3,577	3,172	2,314	90,109	83,250
8 months	570,110	588,325	39,745	26,786	15,662	15,127	625,517	630,238
9 months	652,538	665,684	44,254	30,363	18,834	17,441	715,626	713,488

China Clay Imports for September

A RETURN showing the registered imports of China Clay (including China Stone) into Great Britain and Northern Ireland from the several countries of consignment during the month of September, 1927, indicates that 11 tons, value £112, came from Germany; 100 tons, value £133, from Belgium; and that China Clay to the value of £5 came from France. The total was 111 tons, value £250.

China Clay Exports for September

A RETURN showing the exports of China Clay, including Cornish or China Stone, the produce or manufacture of the United Kingdom, from the United Kingdom to each country of destination as registered during the month ended September 30, 1927, is as follows:—

COUNTRY OF DESTINATION.	QUANTITY. VALUE.	
	Tons.	£.
Russia	342	341
Estonia	420	429
Latvia	309	587
Sweden	3,846	7,139
Norway	1,366	1,600
Denmark	942	2,576
Germany	4,504	9,137
Netherlands	3,936	7,621
Belgium	3,802	6,086
France	2,290	4,869
Spain	55	174
Italy	2,849	7,400
Greece	5	30
Bulgaria	2	15
China	5	29
United States of America	22,965	46,335
Bombay, via Other Ports	649	2,404
Madras	31	130
Bengal	502	1,805
Straits Settlements	1	14
Australia	62	470
Canada	296	1,029
Total	49,179	100,340

Progress in Cement Making

The Present United States Position

MANY interesting mechanical and chemical developments have contributed to the progress of the cement industry since it began its rapid growth thirty years ago, states the Bureau of Mines, Department of Commerce. The first kilns were vertical, like lime kilns, and operations were intermittent. An attempt was made to improve operation by making it continuous, but as this change could at most only double the output, interest was soon directed toward the rotary kiln which was in use in England. This type of kiln was first introduced into the United States in 1889. Its use necessitated radical change in the form of fuel, for the vertical kiln had used coke or coal interbedded with the stone, but the rotary required a gaseous fuel, and this could be supplied only by blowing oil, gas, or pulverised coal in the kiln. This change of kilns and fuel, which became general within the next few years, marks the beginning of the rapid increase in output of Portland cement through increased capacity of plants and lower cost of production.

Other important developments in the industry were the introduction of steam shovels in quarrying, enlargement of crushing, grinding, conveying, and storage facilities, improvements in power plants, introduction of electrical drives, use of mechanical packing and weighing devices, improvement and extension of wet process, finer grinding of raw materials and finished cement, dust collection, increased length and diameter of kilns, enlargement of lower end of kilns, utilisation in power plant boilers of waste heat from rotary kilns, and the use of concrete for plant construction. With all this development has come more accurate chemical control of the product and a gradual improvement of its quality.

Recent Developments

A recent trend in the industry has been toward still further improvements in Portland cement and the development of special qualities, such as the early hardening of the high alumina cements which makes them desirable for road or bridge repair work or for work in cold weather, or where the forms can not long be used. Quick-setting cement has been developed for use in oil wells, and cement with good plasticity and water-retarding properties for use in stucco finish. To some extent the efforts to produce improved Portland cement have led experiments outside the limits of that type of cement officially defined as "the product obtained by finely pulverising clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials with no addition subsequent to calcination except water and calcined or uncalcined gypsum." Certain

of the departures are fused cements high in iron and alumina or in titanium.

Detailed statistical information in regard to the operations of the cement industry are contained in Bureau of Mines publication "Cement in 1924," by E. F. Burchard and B. W. Bagley, copies of which may be obtained from the Superintendent of Documents, Washington, D.C., at a price of 5 cents.

Death of Mr. W. G. Wales

MR. WILLIAM GARNEYS WALES, A.M.Inst.C.E., whose death has occurred at Sunning Hill, Little Forest Road, Bournemouth, formerly resided in Cornwall, and was associated with the China Clay industry. Ill-health, however, necessitated his removal to a drier climate. He went to Switzerland for a time, but later returned to Bournemouth. He was a son of of the late Brigade-Surgeon Wales, of Torquay.

China Clay in Northern Ontario

IN order to determine the value of the belt for commercial purposes, the Ontario Department of Mines will shortly carry out examinations and tests of the deposits of China Clay along the Metagami River. The operations will take the form of borings and drillings in the district, through which the Government hope to be able to make a fairly accurate estimate of the quantity and quality of the clay.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

[NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]

ASHFORD AND NACCOLT BRICK TILE AND POTTERIES, LTD. (late ASHFORD AND DISTRICT BRICK AND TILE CO., LTD.). Registered September 14, £2,000 and £1,000 mortgages, to building society and J. Kingsford, Well-dene, Ashford (Kent), solicitor and others; charged on mesuages at Naccolt, Wye. *£5,000. January 17, 1927.

JACKSONS MILL-BOARD AND PAPER CO., LTD., London, E.C. Registered August 29, mortgage to bank; charged on properties at Wooburn, Bucks, etc. *£1,530 debentures. August 3, 1927.

SPICERS, LTD. (late SPICER BROTHERS, LTD.), London, E.C., paper makers. Registered September 1, £12,000 and any further advances, etc., not exceeding £200 mortgage, to London Life Association, Ltd., 81, King William Street, E.C.; charged on certain properties in township of Marshalls, district of Johannesburg. *£165,952 rs. 8d. June 25, 1926.

Satisfactions

MEAKIN (J. AND G.), LTD., Hanley, earthenware manufacturers. Satisfaction registered September 16, £4,200, part of amount registered May 3, 1909.

YORK AND ACOMB BRICK WORKS, LTD. Satisfaction registered September 17, £6,000, registered January 24, 1927.

Deed of Arrangement

SMITH, John, George Street Pottery, Tunstall, earthenware manufacturer. Filed September 24. Trustee: R. E. Clark, 17 Albion Street, Hanley, C.A. Secured creditors, £9,500; liabilities unsecured, £15,017; assets, less secured claims, £4,839.

London Gazette, &c.

Company Winding Up Voluntarily

LANTERN CHINA CLAY CO., LTD. By special resolution, August 19, confirmed September 5. G. H. Morley appointed as liquidator.

The China Clay Trade Review

The Official Organ of the China Clay Industry and the only Journal specially devoted to its interests. Published in the third issue of "The Chemical Age" each month.

All Editorial communications should be addressed to the Editor, "The China Clay Trade Review," Benn Brothers, Ltd., Bouverie House, 154, Fleet Street, E.C.4. All communications relating to Advertisements, Subscriptions, etc., should be sent to the Manager, "The China Clay Trade Review," at this address. Telegrams—"Allangas, Fleet, London." Telephone—City 0244 (10 lines).

China Clay Industry Rating System

From a report presented by the Rating and Valuation Committee of the St. Austell Rural District Council to the last meeting of that body it will be seen that a serious difference of opinion exists between the rating authority and the China Clay industry as to what system of rating shall be put into operation under the new Rating and Valuation Act, which, so far as the St. Austell Rural District is concerned, it was recently decided shall not come into operation until April, 1929. In some other districts of Cornwall the commencing date of its operation has been fixed for April, 1928.

A New System Proposed

For the first time the fact is disclosed to the public, through the remarks of the St. Austell Rural Rating Committee's chairman, that it is proposed to introduce an entirely new system of rating of the China Clay works of Cornwall, which new system it appears from a letter received by the Rural Council from the China Clay industry is not acceptable to them, as they prefer to continue the present system. This system has been in vogue ever since the industry became an important one in Cornwall, now some 80 years ago, and successive rating authorities have continued rating the China Clay works on the present basis, because they have considered it one which, taken on the whole, was equitable to all parties—to the China Clay industry as an industry, and to the rating authority as representative of the general body of ratepayers.

The Present System

To understand the system it is necessary to explain briefly the method by which the China Clay industry is carried on by the China Clay producers. In very few cases are the actual producers of China Clay the owners of the China Clay deposits which they develop, working them on leases from the China Clay owners on certain terms. These terms generally take the form of a lease for a number of years, ranging from 21 years upwards. Under the terms of the lease the lessee has to pay a minimum annual rent which ranges from £50 to £500 per annum for individual works, according to the stage of development they have reached and the quality of clay produced. Coincident with the amount fixed in the leases for the minimum rent, dues or royalties of so much per ton are also given, with the proviso that where the dues payable on tonnages marketed exceed the minimum rent, such minimum rent merges in the amount payable as dues. That is to say, where works do not pay in dues more than the amount of the minimum rent, they pay the minimum rent, but where the amount of dues exceeds the amount of the minimum rent, they pay the dues.

Method of Assessment

As regards the method of assessing the China Clay works for rates, the custom has always been to rate them on the minimum rent or the dues payable in any one year, whichever amount is the higher. Though in some cases this system has inevitably produced anomalies—especially in the cases of certain works where the minimum rents are high and the quantity of clay marketed has been low—

the system generally has worked well and has been acceptable to the general body of clay producers, as well as to the rating authorities. The system has in it the elements of simplicity and a protection against evasion, the minimum rents and the dues paid to the landowners being always ascertainable. There has never been any question in the past that this method of rating, which has been applicable to the China Clay industry, has not operated smoothly and without any serious objection on the part of rating authorities. It has come as a surprise therefore to the industry, and has become a serious bone of contention between it and the rating authority, that any proposal to revolutionise this old system should now be put forward by the latter.

Conciliation Urged

It is well known that for some time the rating authority has endeavoured to get the China Clay industry to join it in a round table conference to discuss this important matter of rating. Up to the present the China Clay industry has declined to enter into a conference which proposes any change in the present system, but the industry has expressed willingness to confer with the rating authority to consider the present system in the light of the new Rating and Valuation Act. It is this refusal of the China Clay industry to meet the rating authority unconditionally that gave rise to the comments at the last meeting of the Rural Council. The feeling is growing in the district that the St. Austell Rural Council would be well advised to meet the industry in conference on the terms of their letter, namely, to consider the applicability of the present system to future rating with a view to avoiding a deadlock.

Now that the China Clay industry is entering upon what it is hoped will develop into an era of greater prosperity, it would be unfortunate if the adoption of a new system of rating were to embarrass its development, as it is feared it would do if persisted in. As the staple industry of a large part of Cornwall and a big area in Devon, and as one of the largest rate producers, it is entitled to every consideration at the hands of the rating authorities. It is to be hoped that with the ventilation of the subject at this stage, it may be possible for the Rural Council to adopt a course that will enable the industry to lay before it their reasons for preferring the continuance of the present method of rating rather than the adoption of an entirely new system, which is likely to be detrimental to the best interests of all concerned.

The Board of Trade Returns

The Board of Trade returns for October indicate that clay exports were as follows: China Clay, including Cornish or China Stone, 58,015 tons, valued at £115,328, compared with 41,569 tons (£90,511) and 64,680 tons (£136,614) in October, 1926 and 1925 respectively; for the ten months ended October 31, the exports were 539,369 tons (£1,125,592), compared with 554,330 tons (£1,152,367) and 546,507 (£1,134,971) in the same periods in 1926 and 1925 respectively. Total exports of all kinds of clay (China Clay, fireclay, etc.) in October were valued at £153,148, and for the ten months ended October 31, £1,549,281, as compared with £138,889 and £1,638,847 for the same periods in 1926.

The Properties of Solid Colloids

A Paper by a French Chemist

As more and more attention is being paid to the science of colloids in its application to industry, and as the subject is being studied in its applicability to China Clay and the use of the latter in specialised articles of consumption, any new light thrown on the subject by industrial chemists is of more than passing interest to the China Clay industry. That being the case, the following observations of a French chemist, M. Jacques Duclaux, should prove interesting to all interested in the chemistry of China Clay.

APROPOS of M. Duclaux's observations in his paper, it is interesting to recall the remarks of the late Mr. Frank Weston in a former issue of this journal regarding the relation of colloid chemistry to China Clay. He described colloidal clay as clay in such a fine state of division that when mixed with water under certain conditions it forms a colloidal solution; that is, the clay remains in colloidal suspension and does not settle out; moreover, on filtration through filter-paper, it passes through unchanged. Mr. Weston had great faith in the future possibilities of the production of colloidal clay from China Clay for highly specialised uses for which China Clay, in its less refined state, is unsuitable.

Optical Properties

M. Duclaux says that it has been known for over a century that many substances which are classified as amorphous, that is, as possessing no crystalline faces, have optical properties very similar to those of crystals, and, more particularly, that they exhibit double refraction. This can very easily be observed by placing these substances between two inclined mirrors, one acting as a polariser and the other as analyser. This was the method used by Malus in 1810 for observing the bi-refraction of a very large number of natural substances, including the fibrous and transparent portions of leaves and flowers, the thin pellicle covering sapwood, silk, wool, white hair, scales, horn, ivory, feathers, skins of quadrupeds, and fish, shells, and whalebone. It is thus seen that the bi-refraction of organised substances (or, to use a more modern designation, of solid colloids) is quite general, and that the idea of attributing a micro-crystalline structure to these amorphous substances (as was done by Malus) is by no means new.

The list given by Malus is long, and we need not add to it, unless it be that of substances possessing exceptional interest. Among these may be mentioned starch, which was studied particularly by Biot (*Annales de Chimie et de Physique*, 3rd Series, 1844, p. 100). When a grain of starch (preferably potato starch, as the phenomena are clearer owing to the size of the grain and smoothness of its surface) is observed between crossed Nicol prisms, there is seen a black cross, with curved arms, the intersection of which is at the hilum of the grain. The absolute value of the bi-refraction is practically the same in all portions of the grain, showing that all portions are composed of the same substances; but the direction of the bi-refraction varies at different points, and the appearance shows at once how the orientation varies; if the starch grain is considered as being formed of concentric homothetic layers, the orientation remains constant along any given radius, and its value is in a constant ratio to the direction of the plane tangent to the grain at the intersection of the radius with the surface of the grain.

As a starch grain is effectively built up in concentric layers, we must conclude that, as they are being deposited, the particles are polarised by the action of the molecules that are already in position; and consequently the analogy between a starch grain and a crystal does not reside merely in its bi-refraction, but also in its method of formation.

Colloids and their Constitution

The problem we are trying to solve is that of the atomic structure of colloidal substance in the solid state. At the present time, we know how to determine the geometrical position of atoms in crystals, and we can give numerical values to their co-ordinates; but we are far from having reached such an advanced stage in the case of colloids.

Colloidal solutions are known to be of micellar nature; that is, they are formed of extremely fine particles, or micellas, suspended in a liquid. These particles, or micellas, are in all respects analogous to the molecules existing in ordinary solutions, but are much larger. Like ordinary molecules, they may or may not be ionised; knowledge of their chemical composition and of the number and nature of their ions is

sufficient to furnish an explanation of most of their chemical and physical properties, or, more exactly, enables us to understand these properties by comparing them with similar properties of ordinary solutions. There still remain, however, a large number of obscure points that could be cleared up by a knowledge of the atomic structure of the micella. For example, ordinary solutions are known to acquire their final and ultimate properties as soon as they are formed; while colloidal solutions, on the contrary, frequently are in a sort of metastable condition, which reveals itself by a slow and irreversible modification in properties. There seems to take place a rearrangement of the atoms in the micella, that is, a modification of the structure that we are trying to define.

The Solvation Theory

Similarly, the relationship between the micella and the solvent are as yet unknown. The solvation theory attributes a very great importance to the combination between the micella and the solvent; but we are forced to take for granted this combination, the existence of which has not been proved, and the possibility of which depends on the structure of the micella. Some investigators regard it as a sponge, which swells by absorption of the solvent; others, as a massive crystal; and so far, except in a few isolated cases, there is no decisive experimental proof in favour of one belief rather than the other.

The exact nature of the stability of colloids and of the nature of coagulation also gives rise to contradictory interpretations, which are supported in each case by arguments that are not decisive. It is evident, therefore, that investigations that would permit of defining the atomic structure of the micella are of considerable importance from the point of view of colloid chemistry.

Colloids in the Solid State

But when we come to consider colloids in the solid state instead of in solution, these investigations are of much greater importance. Comparison with crystalline solids merely brings out inexplicable differences. Everything relating to the state of solid colloids and to their formation from micella solutions, is obscure, and we have no answers to offer to the innumerable questions that are continually brought up.

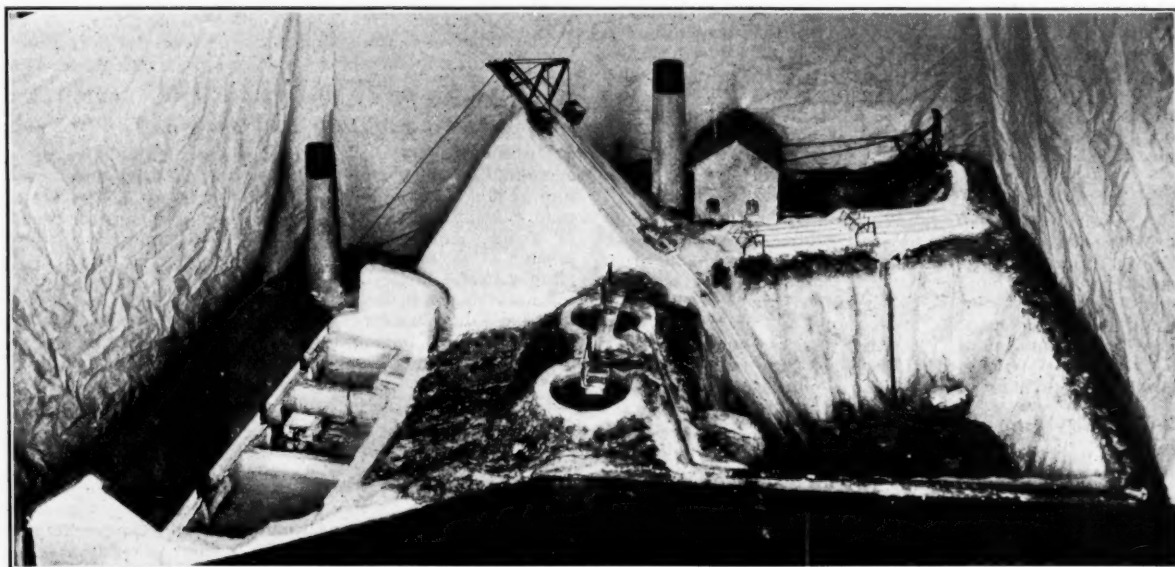
So far, chemical methods, that is, analysis in its various forms, has furnished no explanation; but this is due, not to any theoretical weakness of the method, but rather to the very great experimental difficulties involved, as can be readily seen from the following examples.

Starch and cellulose have the same elementary composition, $C_6H_{10}O_5$, but their properties are very different. Chemical methods have shown that they are both derived from glucose by condensation, with elimination of water; but one of them is derived through maltose, and the other through cellobiose. We can understand that their properties should be different, without being in a position to explain why. If we could isolate and identify the higher condensation products (for there are many intermediate products between maltose and starch), we could understand much better the nature of these differences, but such investigations are long and difficult.

Let us now consider two nitrocelluloses having the same nitrogen content, one of which gives a very good celluloid, and the other a brittle celluloid. Chemical analysis does not show any essential difference between the two, and it might be thought that there are no chemical differences; but it is much more probable that some difference exists, but that it is within the range of some experimental error. Here, again, we find the chemical methods hampered by experimental difficulties; and to those who are familiar with the difficulty of increasing the accuracy of chemical determinations to an additional decimal place, these difficulties are very discouraging.

(To be concluded)

A Working Model of a China Clay Works



MR. R. W. VARCOE'S MODEL.

MR. R. WENTWORTH VARCOE, director of Varcoes China Clays, Ltd., of Stoke-on-Trent and St. Austell, has exhibited before the Ceramic Society a working model of a China Clay works, a photograph of which is shown above. In his explanatory note on the model, Mr. Varcoe states that "China Clay is found in Cornwall mixed with quartz and other impurities, the yield of Clay being about 10 to 15 per cent., on the average. Usually the Clay is found in what might be described as a hole in the earth resembling a basin, which might be hundreds of yards across and as many as 250 ft. deep. The process of separation of the Clay from the quartz depends upon the fact that the Clay can remain in suspension in slowly moving water. The method of separating the Clay from the quartz is by means of a jet of water played upon the Clay material, the resulting stream carrying the Clay to the sandpits, where the smaller particles of sand carried along by the stream are

deposited, the sand being removed from these pits by an automatic tip wagon and deposited on the dump. The China Clay stream then runs along to the sump and is pumped to the surface passing to the micas—a series of parallel troughs where the finer sand and mica and the coarser Clay are deposited. The purified clay stream then passes to the settling pits, where the stream, being introduced near the bottom, rises very slowly to the surface, the Clay falling into suspension; from these pits pure water runs off at the top, and Clay of about the consistency of cream escapes at the bottom. The Clay then runs to the tanks, where it is collected and further thickened to the consistency of butter. From the tanks it is taken in small barrows or trucks to the 'dry,' and spread to a depth of about eight inches. The excess moisture is here driven off by heat. From the 'dry' the Clay is then removed to the linhay, the moisture content being about 12 per cent. Here the finished article awaits shipment."

China Clay Exports for October

A RETURN showing the exports of China Clay, including Cornish or China Stone, the produce of the United Kingdom, from the United Kingdom to each country of destination as registered during the month ended October 31, 1927.

COUNTRY OF DESTINATION.	QUANTITY. VALUE.	
	Tons.	£.
Finland	4,620	8,102
Sweden	1,605	3,732
Norway	820	1,305
Denmark (including Farøe Islands)	222	450
Germany	1,677	3,006
Netherlands	4,184	9,529
Belgium	5,932	9,192
France	3,994	6,460
Portugal	101	291
Spain	1,834	3,501
Italy	895	2,681
Egypt	11	51
Siam	2	11
China	5	26
United States of America	25,846	51,273
Mexico	137	703
Peru	10	45
Brazil	2	15
Argentine Republic	750	2,500
Irish Free State	1	1
Channel Islands	1	4
Bombay	1,895	5,464
Madras	20	161

Bengal, Assam, Bihar and Orissa	305	988
Australia	99	629
New Zealand	1	11
Canada	770	2,082
Newfoundland and Coast of Labrador	2,276	3,016
Total	58,015	115,328

October Deliveries

OCTOBER deliveries did not quite come up to the total deliveries made in September, being nearly 5,000 tons below, but China Clay deliveries were within 900 tons of September's total of 82,428 tons. Buyers are expediting the execution of orders to accumulate stocks against the new year. The deliveries of all classes of products are, on the ten months, now 24,000 tons above the corresponding period last year, and the deliveries of China Clay alone are above for the first time this year.

Details:—

Port.	CHINA CLAY.		CHINA STONE.		BALL CLAY.		TOTAL.	
	1927.	1926.	1927.	1926.	1927.	1926.	1927.	1926.
Fowey	65,541	47,526	2,475	3,025	1,019	70	69,035	50,621
Charlestown	4,384	2,940	—	—	—	—	4,384	2,940
Par	4,932	4,436	330	42	—	—	5,262	4,478
Penzance	1,023	—	—	—	—	—	1,023	—
Plymouth	715	1,013	—	—	—	—	715	1,013
Looe	385	—	—	—	—	—	385	—
Falmouth	—	130	—	—	—	—	—	130
By rail	4,533	4,309	—	—	—	—	4,533	4,309
October	81,513	60,354	2,805	3,067	1,019	70	85,337	63,491
9 months	652,538	665,684	44,254	30,393	18,834	17,441	715,626	713,488
10 months	734,051	726,038	47,059	33,430	19,853	17,511	800,963	776,979

China Clay Notes and News

Shipping Agents' New Office

The Fredk. Hobbs Chartering Co., Ltd., of Poole and Fowey, write stating that it may be of interest to readers of THE CHINA CLAY TRADE REVIEW to know that they have opened an additional office at Bristowes Chambers, Poole, with telegraphic address "Chartering-Poole," and telephone no. 300. They of course still retain their office at Fowey. This office will be under the personal control of Mr. F. A. Hobbs.

Mr. Henry Van den Bergh

Mr. Henry Van den Bergh, chairman of the New Consolidated Mines of Cornwall, Ltd., and a director of the British Widows Assurance Co., Ltd., has decided to resign his position on the board of Van den Berghs, Ltd., margarine manufacturers, which has recently combined with Anton Jurgens. His resignation will take effect as from December 31, 1927, but he has agreed to continue to act after that date as honorary adviser to the board. Mr. Van den Bergh has been connected with Van den Berghs, Ltd., since his early youth.

China Clay Imports for October

A return showing the registered imports of China Clay (including China Stone) into Great Britain and Northern Ireland from the several countries of consignment during the month of October, 1927:

COUNTRIES WHENCE CONSIGNED.	QUANTITY.	VALUE.
	Tons.	£
Germany	1	12
France. Add to amend September, 1927	2	—
U.S. America	46	730
	—	—
Total	49	742

American Clayworkers to Visit England

Arrangements are being made for a visit of the American Ceramic Society (which includes all makers of clay goods) to Great Britain from May 19 to July 5, 1928. Mr. Ross C. Purdy, the secretary of the American Ceramic Society, has been paying a visit to Europe to make preliminary arrangements. The party will start from Montreal, and will first visit Scotland. From thence they will travel to Stoke-on-Trent, arriving in London the first week in June. They will then proceed to Delft, Amsterdam, Berlin, and other German towns; they will take a short rest at Lucerne before making their way to Paris.

China Clay and the New Rating System

At the last meeting of the St. Austell Rural Council, Mr. E. B. Vian submitted the Rating and Valuation Committee's report, which contained references to the valuation of the China Clay industry. The report stated that despite the efforts of Mr. A. S. Coldham (the clerk), the representatives of the China Clay industry had declined unconditionally to join in a round table talk. The industry would meet them only on the understanding that the present method of rating the clay works would be adopted, which would, of course, not be the method of rating in the future. Mr. Vian commented that it was a great pity that the industry declined to meet them to discuss a new system.

Receiver Appointed for Clay Co.

Mr. T. A. V. Wood, of St. Austell, was appointed receiver-manager of the West Hensbarrow China Clay Co., of St. Austell, by Mr. Justice Astbury in the Chancery Court on Tuesday, November 1. On behalf of Mr. C. C. S. Barry, for himself and other mortgage debenture holders, Mr. Lavington moved for the appointment of Mr. T. A. V. Wood, of St. Austell. The defendant company had not appeared. The China Clay industry, counsel said, had not been in a very flourishing state for some time. The plaintiff held £500 debentures. The debentures had crystallised. His Lordship observed that service of the notice had been at the defendants' registered office, one service by post and the other by leaving at the office. He could not understand what the plaintiff had been doing for five years. Mr. Lavington said he did not

know. It was not very satisfactory. No interest had been paid for five years, and nobody had done anything.

The judge made the appointment on security in 21 days on the plaintiff's undertaking, and said that Mr. Wood would continue to act as manager for three months.

St. Austell's £50,000 By-Pass Road

Mr. F. W. Mutton, chairman of the Urban Council, responding to the toast of his health at a luncheon given by him in honour of the opening of the St. Austell new by-pass road (costing £50,000) by Sir Hy. Maybury, Director-General of Roads, said he looked upon the consummation of that scheme as one step nearer to the salvation of St. Austell. He alluded to the daring of the Urban Council in undertaking the scheme when, as it then was, with an acreage of only 196 and a rateable value of only £15,000, it agreed to put down £10,500 towards the making of the by-pass road. Bearing that in mind, some might think that it was a difficult thing to justify. But it was not difficult to justify having regard to their industrial life and the fact that nature had placed them in the centre of unlimited deposits of the finest qualities of China Clay in the world. He referred to the benefit to the China Clay and other industries of increased facilities for cheaper transport, and thought that the council could in one way and another assist in fostering the development of the China Clay industry, whereby a great quantity of that mineral could be disposed of. At present the output was approaching a million tons per annum. There was no reason why that should not be greatly increased. Their aim should be to reduce costs in order to cheapen it and make that increased output possible. It was the duty of authorities like that of St. Austell to assist in that direction, and by providing increased facilities for better transport they would cheapen transport costs, which were a big item in the marketing of China Clay.

He alluded to the possibilities of providing one-way traffic through the town, and to the desire of the Council to co-operate with the business men of the district in increasing the wealth of all concerned and wiping out unemployment.

China Clay Owners' Secretary

His appearance in the courts represents only a small part of his activities in the legal profession, writes a correspondent with reference to Mr. Walter Graham, of St. Austell, for he has gained a high reputation as a commercial lawyer, and in that capacity has piloted many China Clay and other commercial firms through the intricacies of company law. He has a direct official interest in the China Clay industry, for he is the secretary of the China Clay Owners' Federation, an organisation formed in 1919 to safeguard and watch the interests of China Clay owners as distinct from the interests of the China Clay producers.

The prosperity of China Clay landowners is inseparable from the prosperity of the China Clay producers; the latter have had little to complain of from the Owners' organisation, which, under the guidance of its capable and conciliatory secretary, has seldom acted in an arbitrary manner. At one time there was a little anxiety amongst the China Clay producers lest the owners should place obstacles in the way of their complete realisation of their opportunities from a financial point of view, but that anxiety no longer exists to any appreciable extent, thanks to the accommodating attitude which has been adopted towards the lessees.

Another direction in which Mr. Graham has exercised a progressive policy in connection with the development of the China Clay industry has been in fostering the possibilities of Par Harbour for the shipment of China Clay. The late Squire C. E. Treffry and, since his death, Colonel Edward Treffry, have had in Mr. Graham a representative who, while ever watchful of their interests, has been quick to see that the provision of facilities for the quick and economical transport of China Clay would react favourably upon the fortunes of the estate. The scheme for the opening up of sites for China Clay dries at Par, to which liquid clay is piped from the works several miles distant, thus effecting a considerable saving in transport charges on clay and coal, was one which Mr. Graham was responsible for recommending for adoption by the estate, with very beneficial results to all parties.

Shipping and Export News of the Month

We give herewith latest particulars relating to arrivals and sailings of ships engaged in the China Clay trade, at the principal British clay ports. Registered exports of China Clay, with countries of destination, and other shipping and export matters are dealt with.

Fowey Shipping—September, 1927

Arrived.	Name.	Sailed.	Destination.
September	1, s.s. <i>Loch Leven</i>	September	6, Glasson Dock
September	1, s.s. <i>Brier Rose</i>	September	3, Runcorn
September	1, s.s. <i>Mondara</i>	September	6, Preston
September	1, s.s. <i>Opal</i>	September	7, Antwerp
September	1, s.s. <i>Rossmore</i>	September	7, Bo'ness
September	1, M.V. <i>M.E. Johnson</i>	September	11, Weston Point
September	1, s.s. <i>Mersey</i>	September	5, Ridham
September	3, s.s. <i>Exeter City</i>	September	12, Portland, Me.
September	3, M.V. <i>Ocean</i>	September	9, Oscarsham
September	3, s.s. <i>Farfield</i>	September	9, Grimsby
September	4, s.s. <i>Treue</i>	September	10, Par
September	4, s.s. <i>Ciscar</i>	September	9, Genoa
September	4, s.s. <i>Beryl</i>	September	9, Rouen
September	5, s.s. <i>Deneside</i>	September	8, Dunkirk
September	5, s.s. <i>Thurston</i>	September	15, Philadelphia
September	5, s.s. <i>Hallton</i>	September	10, Antwerp
September	6, s.s. <i>Hayle</i>	September	10, Runcorn
September	6, s.s. <i>Moss Rose</i>	September	12, Fleetwood
September	6, s.s. <i>Moygannon</i>	September	10, Weston Point
September	6, s.v. <i>Trevellas</i>	September	27, Runcorn
September	7, s.v. <i>Dannebrog</i>	September	17, Aarhus
September	7, s.v. <i>Lady Jean</i>	September	17, Newhithe
September	7, s.v. <i>Lady Rosebery</i>	September	17, Alesford
September	7, s.v. <i>Fuglen</i>	September	17, Fredrikshald
September	9, s.s. <i>Guelder Rose</i>	September	14, Preston
September	9, s.s. <i>Pansy</i>	September	13, Weston Point
September	9, s.s. <i>Hampshire Coast</i>	September	13, Liverpool
September	9, M.S. <i>Munkfors</i>	September	13, Gothenburg
September	10, s.s. <i>Gouwestroom</i>	September	16, Amsterdam
September	11, s.s. <i>Border Firth</i>	September	15, Hamburg
September	12, s.s. <i>Hvitra</i>	September	17, Gefle
September	12, M.S. <i>Dickie</i>	September	16, Gothenburg
September	12, s.s. <i>Blush Rose</i>	September	16, Preston
September	12, s.s. <i>Horsham</i>	September	17, Terneuzen
September	13, s.s. <i>Sproit</i>	September	16, Skien
September	14, s.s. <i>Aspen</i>	September	19, Liverpool
September	14, s.s. <i>Ferndene</i>	September	19, Hamburg
September	14, s.s. <i>Mersey</i>	September	16, Ridham
September	14, s.s. <i>Austin Gough</i>	September	19, Antwerp
September	15, M.V. <i>Regina</i>	September	16, Plymouth
September	15, M.V. <i>Mayblossom</i>	September	16, Polperro
September	15, s.v. <i>Jane Banks</i>	*	Newcastle
September	17, s.s. <i>Vancouver Maru</i>	September	27, Portland, Me.
September	17, M.V. <i>Hope</i>	September	20, Torquay
September	17, s.s. <i>F. W. Fischer</i>	September	23, Kotka
September	17, s.s. <i>Magrix</i>	September	20, Antwerp
September	17, s.s. <i>Harptree Coomb</i>	September	22, Antwerp
September	18, s.s. <i>Joffre Rose</i>	September	21, Grangemouth
September	18, s.s. <i>Primrose</i>	September	20, Weston Point
September	18, s.s. <i>Taycraig</i>	September	22, Preston
September	18, s.s. <i>Solway Firth</i>	September	17, Rouen
September	18, s.s. <i>Knowl Grove</i>	September	17, Gravesend
September	19, s.s. <i>Brier Rose</i>	September	21, Manchester
September	20, s.s. <i>Glencreagh</i>	September	22, Gravesend
September	21, s.s. <i>Clan Macvicar</i>	September	23, Bombay via Newport
September	22, M.V. <i>Romanie</i>	September	24, Gijon
September	22, s.s. <i>Hayle</i>	September	26, Runcorn
September	22, s.s. <i>Rossmore</i>	September	24, Bo'ness
September	22, s.s. <i>Eskbridge</i>	September	29, Philadelphia
September	23, s.s. <i>Glenaster</i>	September	30, Portland, Me.
September	23, s.s. <i>Horn</i>	September	24, Newport
September	25, s.s. <i>Blush Rose</i>	September	27, Runcorn
September	26, s.s. <i>Calcaria</i>	September	28, Avonmouth
September	27, s.s. <i>Farfield</i>	October	1, Preston
September	27, s.s. <i>Horn</i>	September	29, Cardiff
September	27, s.s. <i>Afon Dulais</i>	September	30, Brussels
September	27, s.s. <i>Brookside</i>	October	3, Antwerp
September	28, s.s. <i>Thames Maru</i>	*	Portland, Me.
September	28, s.s. <i>Gouwestroom</i>	*	Amsterdam
September	28, s.s. <i>Johann Ahren</i>	*	Kotka
September	28, s.s. <i>Jarrix</i>	October	1, Leith
September	29, s.s. <i>Heinz Ferdinand</i>	*	Raumo
September	29, s.s. <i>Moss Rose</i>	*	Weston Point
September	29, s.s. <i>Hallton</i>	*	Liverpool
September	29, s.s. <i>Rayford</i>	*	Methil
September	30, s.s. <i>Chicago City</i>	*	New York
September	30, s.s. <i>Stanwell</i>	October	3, Antwerp
September	30, s.s. <i>Estella</i>	*	

* Signifies "In Port."

Fowey Shipping—October, 1927

Arrived.	Name.	Sailed.	Destination.
October	1, s.s. <i>Scotsman</i>	*	Erith
October	1, s.s. <i>Horn</i>	October	8, Pasages
October	3, M.V. <i>Regina</i>	October	5, Plymouth
October	3, s.s. <i>Mersey</i>	October	7, Ridham
October	3, s.s. <i>Tanny</i>	October	7, Bristol
October	3, M.V. <i>Lyhner</i>	October	5, Plymouth
October	3, s.v. <i>Malvoisin</i>	October	12, Gravelines
October	3, s.s. <i>Kenrix</i>	October	8, Antwerp
October	4, s.s. <i>Primrose</i>	October	8, Preston
October	4, s.s. <i>Austin Gough</i>	October	8, Rouen
October	4, s.s. <i>Guelder Rose</i>	October	11, Runcorn
October	4, s.s. <i>Dorrien Rose</i>	October	10, Runcorn
October	4, M.V. <i>Dietrich Hasseldieck</i>	October	8, Sodertelje
October	4, s.s. <i>Greta</i>	October	8, Gothenburg
October	4, s.s. <i>Golfer</i>	October	10, Grimsby
October	4, s.s. <i>Hayle</i>	October	11, Weston Point
October	6, s.s. <i>Brier Rose</i>	October	11, Hull
October	6, s.s. <i>Crofter</i>	October	11, Harburg
October	6, s.s. <i>Blush Rose</i>	October	11, Rouen
October	7, M.V. <i>Lyhner</i>	October	8, Plymouth
October	8, M.V. <i>The Sirdar</i>	October	12, Plymouth
October	9, s.s. <i>Flottbek</i>	October	13, Botwood
October	9, s.v. <i>Flora</i>	October	16, Gothenburg
October	10, M.V. <i>Regina</i>	October	12, Plymouth
October	11, s.s. <i>Charlwood</i>	October	14, Antwerp
October	11, s.s. <i>Ambleside</i>	October	14, Rouen
October	11, s.s. <i>River Fisher</i>	October	12, Plymouth
October	11, s.s. <i>Sturdee Rose</i>	October	14, Brussels
October	12, s.s. <i>Falconer</i>	October	15, Bremen
October	12, s.s. <i>Kyle Firth</i>	October	15, Antwerp
October	13, M.V. <i>Lyhner</i>	October	13, Plymouth
October	13, s.s. <i>Suffolk Coast</i>	October	15, Liverpool
October	13, M.V. <i>William Ashburner</i>	October	18, Gravelines
October	14, s.s. <i>Mersey</i>	October	15, Ridham
October	15, s.s. <i>Haig Rose</i>	October	18, Preston
October	15, s.s. <i>Sweden Maru</i>	October	22, Portland, Me.
October	15, s.s. <i>Moss Rose</i>	October	19, Runcorn
October	15, M.V. <i>Lydia Cardell</i>	October	24, Rouen
October	15, s.s. <i>Ravenspoint</i>	October	19, Genoa
October	17, s.v. <i>Alert</i>	October	26, Newcastle
October	17, s.s. <i>Rossmore</i>	October	19, Bo'ness
October	18, M.V. <i>Lyhner</i>	October	19, Plymouth
October	18, s.s. <i>Rayford</i>	October	20, Methil
October	18, s.s. <i>Pansy</i>	October	20, Ridham
October	18, s.s. <i>Primrose</i>	October	21, Runcorn
October	19, s.s. <i>Gronant Rose</i>	October	22, Runcorn
October	19, M.V. <i>A. H. Both</i>	October	22, Trangsund
October	19, s.s. <i>Brier Rose</i>	October	20, Fleetwood
October	19, M.V. <i>Isabel</i>	October	19, Par
October	19, s.v. <i>Mary Miller</i>	*	
October	19, s.v. <i>Hilda</i>	October	29, London
October	19, s.s. <i>Baron Nairn</i>	October	27, Philadelphia
October	19, s.s. <i>Brookside</i>	October	22, Aviles
October	20, s.s. <i>Carham</i>	October	25, Antwerp
October	20, s.s. <i>Barbara</i>	October	26, Kotka
October	20, s.s. <i>Gower Coast</i>	October	22, Liverpool
October	20, M.V. <i>Neptunus</i>	October	29, Karlskrona
October	20, s.s. <i>Wild Rose</i>	October	25, Brussels
October	21, s.s. <i>Rosafred</i>	October	26, Harburg
October	21, s.v. <i>Waterwitch</i>	*	Runcorn
October	21, s.v. <i>Eve</i>	October	22, Penryn
October	21, s.s. <i>Pamela</i>	October	27, *
October	22, s.s. <i>Enigheden</i>	October	27, Skien
October	23, s.s. <i>Blush Rose</i>	October	26, Preston
October	24, M.V. <i>Waldemar Turnoe</i>	October	28, Norrköping
October	24, M.V. <i>Lyhner</i>	October	26, Plymouth
October	24, M.V. <i>Amazon</i>	October	26, Torquay
October	25, s.s. <i>Jellicoe Rose</i>	October	26, Brussels
October	25, s.b. <i>Falken</i>	—	*
October	26, s.s. <i>Gouwestroom</i>	October	29, Amsterdam
October	27, s.s. <i>Mersey</i>	October	28, Ridham
October	27, s.s. <i>Joffre Rose</i>	October	29, Barrow
October	28, s.s. <i>Guelder Rose</i>	*	Antwerp
October	28, s.s. <i>Esso Nile</i>	October	31, Antwerp
October	28, s.s. <i>Briar Rose</i>	*	Penzance
October	28, s.s. <i>Horn</i>	*	Aviles
October	29, s.s. <i>Solway Firth</i>	October	31, Rouen
October	29, s.s. <i>Hayle</i>	*	Preston
October	29, s.s. <i>Taiho Maru</i>	*	Portland, Me.
October	30, s.s. <i>Pansy</i>	October	31, Leith

October 30, s.v. <i>Tormalind</i>	*	Reval
October 30, s.s. <i>Seaforth</i>	November 1,	Bristol
October 31, s.s. <i>Ciscar</i>	*	Genoa
October 31, s.s. <i>Eltham</i>	*	Liverpool

* Signifies "In Port."

Charlestown Shipping—October, 1927

Date.	Vessel.	From
October 2.....	s.s. <i>Relis</i>	Bilbao
October 5.....	<i>Hibernia</i>	Torquay
October 8.....	<i>My Lady</i>	Newport
October 10.....	<i>Mary Watkinson</i>	Cardiff
October 12.....	s.s. <i>Snow Queen</i>	Penryn
October 12.....	s.s. <i>Dinorvic</i>	Poole
October 14.....	s.s. <i>Eilbechtol</i>	Torquay
October 14.....	<i>Clymping</i>	Falmouth
October 17.....	<i>Lady Jean</i>	Truro
October 19.....	<i>Fanny Crossfield</i>	Falmouth
October 19.....	<i>Brooklands</i>	Mevagissey
October 19.....	<i>Tarragonna</i>	Polperro
October 20.....	s.s. <i>Rosalie</i>	Guernsey
October 20.....	<i>I. Milton</i>	Falmouth
October 20.....	<i>B25</i>	Plymouth
October 21.....	<i>Talberg</i>	Roscoff
October 21.....	<i>Primrose</i>	Plymouth
October 22.....	<i>Pet</i>	Falmouth
October 23.....	M.V. <i>Steirmark</i>	Penzance
October 23.....	<i>Englishman</i>	Truro
October 25.....	<i>Gauntlet</i>	Cardiff
October 28.....	s.s. <i>Jolly Norman</i>	Truro
October 29.....	s.s. <i>System</i>	Truro

Date.	Vessel.	Destination.
October 1.....	s.s. <i>Jolly Norman</i>	Aberdeen
October 5.....	s.s. <i>Relis</i>	Brussels
October 7.....	<i>Hibernia</i>	London
October 12.....	s.s. <i>Dinorvic</i>	Gravesend
October 13.....	s.s. <i>Snow Queen</i>	Liverpool
October 15.....	s.s. <i>Eilbechtol</i>	Terneuzen
October 15.....	<i>My Lady</i>	Humber
October 17.....	<i>Clymping</i>	London
October 18.....	<i>Lady Jean</i>	Rochester
October 21.....	<i>Mary Watkinson</i>	Runcorn
October 21.....	<i>Tarragonna</i>	Rochester
October 21.....	<i>Brooklands</i>	Glasgow
October 21.....	<i>B25</i>	Nantes
October 21.....	s.s. <i>Rosalie</i>	Sunderland
October 22.....	<i>Fanny Crossfield</i>	Runcorn
October 25.....	<i>I. Milton</i>	London
October 25.....	<i>Primrose</i>	Nantes
October 25.....	M.V. <i>Steirmark</i>	Granton
October 25.....	<i>Pet</i>	Runcorn
October 27.....	<i>Englishman</i>	Runcorn
October 29.....	s.s. <i>Jolly Norman</i>	Gravesend
October 29.....	s.s. <i>System</i>	Leith

Par Harbour Shipping—October, 1927

Date.	Vessel.	From
October 3, s.s. <i>Ravenscraig</i>		Kingsbridge
October 4, s.v. <i>Flying Foam</i>		Falmouth
October 6, M.V. <i>Heather Pet</i>		Exeter
October 7, M.V. <i>Antigoon</i>		Plymouth
October 7, s.s. <i>Matje</i>		Garston
October 8, s.s. <i>Artificer</i>		Scilly Isles
October 8, s.s. <i>Grado</i>		Karlstad
October 9, s.s. <i>Solway Firth</i>		Exmouth
October 10, s.s. <i>Ardrie</i>		London
October 11, s.s. <i>Edenside</i>		Sunderland
October 13, s.s. <i>Wheatplain</i>		Swansea
October 13, s.s. <i>Pegrix</i>		Dartmouth
October 14, M.V. <i>Katie</i>		London
October 14, s.v. <i>Lady Daphne</i>		Poole
October 15, s.v. <i>Hilda</i>		Hayle
October 15, s.v. <i>Rothersand</i>		Falmouth
October 18, M.V. <i>Isabel</i>		Falmouth
October 19, s.v. <i>John Sims</i>		Port Navis
October 20, s.v. <i>Lady Agnes</i>		Pentewan
October 22, s.v. <i>Daisy</i>		Coverack
October 22, s.v. <i>Duchess</i>		Falmouth
October 23, s.s. <i>Norrix</i>		Teignmouth
October 24, M.V. <i>Capable</i>		Cowes
October 24, s.v. <i>Kate</i>		Falmouth
October 24, s.s. <i>System</i>		Antwerp
October 25, s.v. <i>Penryn</i>		Penryn
October 26, s.s. <i>Wheatcrop</i>		Plymouth

October 31, s.s. <i>Trader</i>	Salcombe
October 31, s.s. <i>Dinorwic</i>	Northfleet
October 31, s.s. <i>Horsham</i>	Southampton

Sailings

Date.	Vessel.	Destination.
October 7, s.s. <i>Ravenscraig</i>		Antwerp
October 7, M.V. <i>Heather Pet</i>		Rochester
October 10, s.s. <i>Matje</i>		Penryn
October 11, M.V. <i>Antigoon</i>		Antwerp
October 11, s.s. <i>Artificer</i>		Aberdeen
October 12, s.s. <i>Solway Firth</i>		Antwerp
October 12, s.s. <i>Ardrie</i>		Plymouth
October 13, s.s. <i>Edenside</i>		Southampton
October 14, s.v. <i>Flying Foam</i>		Queenboro
October 14, s.s. <i>Grado</i>		Rouen
October 14, s.s. <i>Wheatplain</i>		Larne
October 14, s.s. <i>Pegrix</i>		Kirkcaldy
October 19, s.s. <i>Hilda</i>		Fowey
October 20, s.s. <i>Rothersand</i>		Runcorn
October 22, s.v. <i>Isabel</i>		Poole
October 23, s.v. <i>John Sims</i>		Weston Point
October 25, s.s. <i>Norrix</i>		Dundee
October 25, M.V. <i>Capable</i>		Rochester
October 25, s.s. <i>System</i>		Truro
October 31, s.v. <i>Lady Daphne</i>		London
October 31, s.v. <i>Daisy</i>		London
October 31, s.v. <i>Kate</i>		Plymouth
October 31, s.s. <i>Wheatcrop</i>		Fleetwood

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

London Gazette, &c.

Companies Winding Up Voluntarily

J. H. BARRATT AND CO., LTD. By special resolution, September 30, confirmed October 20. F. H. Hardwicke, Sutherland Chambers, High Street, Stoke-on-Trent, chartered accountant, appointed as liquidator.

GREAT ROSEMELLYN CHINA CLAYS, LTD. M. H. Moody, 20, Newgate Street, E.C.1, incorporated accountant, appointed as liquidator, October 12.

Mortgages and Charges

[NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]

COLEFORD BRICK AND TILE CO., LTD. Registered October 5, £3,000 debentures (filed under section 93 (3) of the Companies (Consolidation) Act, 1908), present issue £1,000; general charge. *Nil. March 15, 1927.

COTTAM HALL BRICK AND TILE CO., LTD., Preston. Registered October 21, £1,500 debenture, to G. Starkie, Church Street Wire Mills, Preston, iron and wire merchant; general charge.

KEELE STREET POTTERY CO., LTD., Tunstall. Registered October 24, £2,500 mortgage, to B. Robertson, Newcastle-under-Lyme, solicitor, and others; charged on Keele Street Pottery and 129, High Street, Tunstall; also registered October 24, £1,000 sub mortgage, to C. H. Bowers and others, Tunstall, earthenware manufacturers; charge on above property, and subject to above mortgage. *—, September 22, 1927.

ROBINWOOD HILL BRICK AND TILE WORKS, LTD., Tuffley. Registered October 4, £7,000 (not ex.) charge, to bank; charged on land and brickworks at Tuffley, and lands at Whaddon. *Nil. April 23, 1927.

SUNDERLAND POTTERY CO., LTD. Registered October 25, £560 debentures; general charge. *£2,000. November 1, 1926.

Satisfactions

BARRATT (J. H.) AND CO., LTD., Stoke-on-Trent, tile manufacturers. Satisfaction registered October 5, £4,000, registered March 27, 1915.

The China Clay Trade Review

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China Clay Rating

Since our last issue, in which, apropos of the proposal of the St. Austell Rural District Council's Rating and Valuation Committee, we dealt editorially with the question of the rating of the China Clay industry, the question has been further ventilated; the chairman of the committee (Mr. E. B. Vian) has objected to so much publicity being given to the subject.

Referring to the committee's report at the last meeting, about the unsuccessful efforts they had made to get the clay industry to meet them in conference on the subject of the rating of China Clay works under the new Act, Mr. Vian said unfortunately very much had been made of the remarks he made on the subject. They, as a rating authority, were doing their best to arrange a friendly conference with the trade. He did not object to the constructive criticism, but when the rating committee was doing its best to bring about a solution it was regrettable that at such a time such unfortunate Press comments should appear. Not only were they in the local press, but had been broadcast in the industry's trade journal, THE CHINA CLAY TRADE REVIEW, and the proposed new system commented upon. It was unfortunate that those remarks should be made when they were doing their best to arrange a conference.

Valuation by Experts

The Act said that certain properties must be valued by experts, and that such officials might be engaged. They had engaged Mr. Body of Plymouth, one of the finest valuers in the country, one of five men to go into the whole question of valuing special properties which would be valued by those experts. They were now trying to get a round table conference with the clay producers, and until now they had failed. They had no sinister design on the clay industry—some of them had depended on it for their bread and cheese since they could remember. They wanted to do their best for the district as a valuation authority. They were keeping the public in touch with what was going on so that the public might know that their representatives were doing their utmost to bring about the most equitable distribution of rates that the committee thought proper.

Publicity Not Harmful

Our further comment on the subject is that we do not consider any harm can result from the consideration of a subject which is fraught with so much importance to the China Clay industry. We have no desire to write anything likely to embarrass either the rating committee or the China Clay industry. While the rating committee were negotiating with the industry to secure an interview to discuss the new system proposed, nothing was said one way or the other. It was only after Mr. Vian had declared that the industry refused absolutely to meet the committee unless they were prepared to confer upon the applicability of the existing rating system to the industry, that we thought the time opportune, in a matter of great public interest, to ventilate the subject and to make suggestions that might help to avoid the continuation of a deadlock that may prove expensive to the ratepayers as well as to the industry.

Our Motive

Our only motive in commenting on the subject was to assist and not to hamper the rating committee in their admittedly difficult task, and to emphasise the importance of avoiding a conflict between the rating committee and the China Clay industry. We never suggested that the rating authority was out to hamper the industry, but there is such a thing as inflicting injury unwittingly.

On the question as to whether rating on rents and dues is a proper one for the China Clay industry, there is evidence in favour of it in the neighbouring industry of tin-mining. Many years ago it was laid down by law that mines producing tin, lead, iron, copper, and other minerals must be rated on the rents and dues. Had China Clay been produced at that time it is reasonable to suppose that, as a mineral, it would have been included in that old rating law.

Rating Authority Clerk's Remarks

Since the above was written, the clerk to the rating authority has thrown new light on the subject which may prove helpful in bringing about the right attitude. At St. Austell Rotary luncheon last week, Rotarian A. S. Coldham, clerk to the St. Austell and Bodmin Rural District Councils, gave an interesting address on the new Rating and Valuation Act. He explained that few changes were being made in rating and valuation law, the main changes being made in the bodies, authorities, and machinery set up for dealing with assessments. Under the new Act farmers were to pay on a quarter of the value of their farms, including their buildings, and owners of works or factories employing machinery were to be free of rates on certain classes of machinery. The incidence of rating remained practically the same.

The Position of Clay Works

Rotarian Coldham touched only lightly upon the vexed question of China Clay rating. He explained that the difficulty in dealing with that industry on the basis of rents and royalties was that in the past all the producers had not been prepared loyally to accept that as a basis, especially when they happened to have a bad year, and some of them had appealed on the ground that it was excessive. Moreover, the system produced anomalies of a glaring character.

He agreed that in certain cases in the tin-mining industry rents and dues were legally acceptable as a basis for rating, and if the China Clay industry had desired the same system applied to China Clay works he wondered why they had not got their industry included in the Act of 1874, applying to the rating of hard mineral mines.

The Industry and an Old Act

The point raised by the clerk in reference to the failure of the industry to get China Clay works included in the same provisions as apply to the mineral-mining industry is an interesting one. Probably it was due to the fact that successive rating authorities having always accepted rents and dues as the basis, as a result of co-operation, the industry probably felt that it was not necessary for them to obtain, by a strictly legal process, what they have been able to obtain by mutual arrangement.

The Property of Plasticity

Some Notes on its Nature and Investigation

PLASTICITY is the essential property of clay upon which all methods of work in the ceramic industry are founded, and, we may add, without which this industry would not exist. Closely allied with plasticity are shrinkage and binding power. Many investigations have been made and much has been written on this subject, very frequently with differing and contradictory conclusions. During the last ten years, however, owing to the development of our knowledge of colloids, the ideas hitherto adopted have been completely altered and some precision attained in regard to this much disputed question.

Plasticity, though an essential property of clay, is not, strictly speaking, a characteristic. Resins, celluloid, heated rubber, softened glass, and certain metals are more or less plastic. These substances act like very viscous liquids. A liquid fills all the empty spaces of a vessel, surrounds all the rough parts, and adheres firmly to the sides. Plastic substances act in the same manner, though under the influence of a certain degree of pressure due to tenacity and adhesion of the mass. There are two consequences from this tenacity. In the first place it must not be excessive, but such that an average pressure will give the material the required form and perfectly fill the mould. Secondly the tenacity must be sufficient to prevent the clay from losing its shape under the action of gravity when removed from the mould; briefly, the mass must be of sufficient consistency. From the point of view of tenacity a comparison can be made between the behaviour of liquids and that of plastic substances. The forcing of clay through a draw-plate is perfectly analogous to the flow of water through a pipe.

The Importance of Colloidal Properties

In what was written above, the fact that plastic clay does not consist of one and the same substance, but of a mixture of water and very fine clay dust, was not taken into account. How can this mixture have the same property as a pure liquid? This is the point on which the chemistry of colloids has thrown light. There is a contrast between the solution of a substance in water such as sugar, salt, etc., on the one hand and a mixture of an insoluble mineral dust with water on the other. In the first case the soluble body is perfectly disseminated throughout the liquid with its smallest particles or molecules. No filter can retain such solid particles which form one homogeneous medium with the liquid. An insoluble powder, on the contrary, when thrown into water, produces a suspension. The particles are visible under the microscope, and may be separated by filtration.

Colloid chemistry has shown that there is a third state between solution and suspension, which possesses the same properties as the liquid itself, and by which there is no residue on passage through an ordinary filter. When left at rest the solid particles are not deposited for a great length of time, yet by close examination it is possible to distinguish these suspended particles in the liquid which do not pass through a very fine filter. From these facts known from the study of colloids we can conclude that by increasing the degree of fineness of the dust a suspension can be transformed into a colloidal solution, and the solid mass containing less water should become plastic. This conclusion, however, is not absolute, and the degree of fineness giving plasticity with water varies with the material. It is less great with clay than with other materials.

The Plasticity of Powdered Minerals

Mineralogists assign a certain plasticity to any mineral when reduced to powder. Take, for example, quartz. Treated in the same way as clay it acts differently. It is possible, by kneading it well, to form a cake, but the consistency is not great enough to hold it together. At rest or when moved a transformation takes place. Under heavy pressure the mass looks like a meagre clay, almost dry, and when again kneaded by hand it runs as though suddenly mixed with an excess of water. Then the substance which falls seems to lack moisture when an attempt is made to knead it again, and appears solid. This phenomenon may be explained as follows.

During the operation of mixing the particles press one against the other. Let us suppose that they are in form of spheres

when one will rest on the top of others. Then should there be a change in the form of the mass the particles will slip against each other and leave greater spaces between. This explains the reason why after pressure and kneading there seems to be a want of water owing to the increase of empty spaces, whereas, on the contrary, moving or stirring appears to produce an excess of water through the particles being brought closer together. It can be clearly demonstrated that the change of exterior form produces deformation of the interior empty spaces by means of an india-rubber ball filled with sand and water. A bent glass tube is attached with an impermeable joint to the opening in the ball, and dips into a vessel containing water. Pressure on the ball will not only not eject water but even suck in a certain quantity, and this clearly proves that the deformation of the particles involves a want of water between the grains.

The observations of Le Chatelier on this subject are noteworthy, showing that the lamellar form of the particles of clay plays an important part in plasticity. These scales are clearly visible when clay is diluted with a large quantity of running water. When the turbid water is examined under a ray of light the scales of the clay can be seen moving in the liquid, alternately presenting their large and small surfaces to the light. The lamellar structure is visible under the microscope. It is also important to note that mica and glauconite, with a corresponding degree of fineness, display the same plasticity, and that these minerals are not very hard. These two qualities, only slight hardness and lamellar form of the particles, allow the latter to move without great friction.

Finally, we must conclude that the plasticity of clay is due firstly to the degree of fineness of the particles, and then to their form and only slight degree of hardness. This second condition explains the formation of plastic masses by mixing water with clay and certain minerals, whereas these plastic masses cannot be obtained with other powdered minerals.—*Revue des Matériaux de Construction.*

China Clay Organisation Defended

Its Importance for the Industry

WRITING in the *Western Morning News* in reply to Sir Roger Onslow, Bart., who criticised the new China Clay organisation, "A Small Firm of China Clay Producers" say:—

"It is a matter for regret that Sir Roger Onslow should have considered it necessary to disparage the efforts being made by the China Clay industry to place it on a firm basis financially. He is a landowner and not a China Clay producer, and therefore does not realise the serious disabilities under which the industry has laboured in the last few years, consequent upon over-production. All that the China Clay industry is attempting to do on its own is, what has already been done nationally for the rubber industry, namely, to counteract the downward effect of over-production below an economic level. Producers have too long been at the mercy of buyers and consumers of China Clay, who have been taking advantage of price-cutting and making fabulous profits at the expense of the industry. Even the big firm to which he refers, which is in an exceptional position, has rarely paid more than 2½ per cent. in dividends to its ordinary shareholders, even in its pre-amalgamation days.

"Whenever an attempt is made by the China Clay producers to get a fair price for their product, the bogey of its effect upon the American market is trotted out. The essence of the matter is: Is it preferable for the industry and Cornwall employment that a few more firms should go into liquidation in order to continue supplying America and other buyers with cheap clay which does not allow a fair margin of profit? It is not a question of benefiting a few works producing inferior clays, but of benefiting the industry as a whole, so that it may be in a position to make a return to its shareholders, and keep employed a maximum number of men on development as well as production work at reasonable wages.

"The industry never employed more men or had a bigger wages-roll than when the old association functioned, though the new organisation differs from the old one in many respects.

China Clay Merchant's Interests

The Activities of Mr. H. Stocker

THE chief claim of Mr. H. Stocker to the recognition of the public is in respect of his work as hon. treasurer of the St. Austell District Hospital. From a small cottage hospital he has seen it grow to its present considerable dimensions, involving financial commitments that are no small responsibility for an hon. treasurer to undertake. As the man who has to see that the wherewithal for running the hospital is provided on an adequate scale, Mr. Stocker takes his onerous duties as treasurer cheerfully, having abundant faith in the charitable-mindedness of the public to see that the hospital is not let down. His association with the institution in conjunction with his excellent co-worker, Mr. G. H. Grenfell, the hon. secretary, has been a source of strength to the organisation, and has inspired the confidence of the public in its financial management. Though his work is done behind the scenes, and he seldom appears in the limelight at hospital functions, those who are familiar with its inner working realise how much the St. Austell community owes to Mr. Stocker for raising the services and equipment of the hospital to the present level of efficiency. Apart from his voluminous work as hon. treasurer, Mr. Stocker has been a generous individual supporter, as well as an inspirer of support by others, amongst whom must be included his firm, English China Clays, Ltd., the biggest clay subscribers to the hospital.

Work with English China Clays, Ltd.

Mr. Stocker's father—the late Mr. Edward Stocker—and his brother, the late Mr. Tom Stocker, were pioneers of the China Clay industry, and the founders of the leading firm in the industry—English China Clays, Ltd. From his earliest association with the firm to the present day Mr. Stocker has been the "indoors man," one of the chiefs of the clerical staff, as distinct from his cousin, Mr. Medland Stocker, who for many years has kept an eye on overseas markets. Mr. H. Stocker has seen his firm grow from a staff which you could almost count on the fingers of one hand (in the old days when the office consisted of a room at the rear of Mr. Tom Stocker's residence at "Glenview," 20 years or so ago) to a staff of a score or so accommodated in their imposing offices in High Cross Street, equipped with all the modern devices for the expeditious transaction of business. In the old days the West of England and the Great Beam China Clay Co., to give the firm its original title, carried on its sales organisation in the Midlands—Manchester and Stoke-on-Trent—and was one of the first to centralise in St. Austell. Since then nearly every other firm engaged in the producing side of the China Clay industry has followed suit, realising that it is essential for business that the sales organisation and all the other work incidental to it should be in the centre of production. The name of Stocker has been associated with the production side of the industry from its earliest days, and in the amalgamations that have taken place with Martin Bros. and the North Cornwall China Clay Co., the active association with the family has been continued, Mr. Hy. Stocker being one of the directors of the English China Clays, Ltd.

During the war Mr. Stocker came into prominence as the prime mover and organiser of the successful efforts for raising money by way of National War Bonds and War Savings certificates. The enthusiasm aroused in those weeks of effort will never be forgotten by those who were associated with Mr. Stocker in the campaigns. The results placed St. Austell on the pinnacle of fame by the raising of the largest sums of any town in Cornwall.

Mr. Stocker has interested himself in all sorts of charitable and religious causes. The local branch of the British and Foreign Bible Society has in him a source of strength as hon. treasurer. He is a consistent supporter of St. Mewan Parish Church, where he has held office for many years. He is one of the original members of the St. Austell Lectures Committee, and remains one of the most active. A man sparing of words, who neither seeks nor desires praise for the work he does for the benefit of the community, a believer in compromise (when it involves no sacrifice of principle) if thereby a peaceful solution can be found for a disturbing situation, the essence of reliability, Mr. Hy. Stocker is worthy of the appreciation of the community whom he has served ungrudgingly without desire for reward.

Properties of Solid Colloids

(CONCLUDED FROM LAST MONTH)

THERE is no fundamental reason why a study of the optical properties of colloids should not give as good results as the study of the optical properties of crystals, or organic compounds, or of the inorganic complexes. But, as we shall see, the difficulties to be overcome are very much greater; and certain experimenters did not realise the exact nature of the problems to be solved, and drew hasty and unacceptable conclusions from their results.

Before proceeding, we will define the scope of our discussion. We shall leave aside everything relating to the constitution of micellas, which, like those of gold, silica, etc., do not give a reversible colloid or gel. The general conclusions resulting from their investigation are in agreement with the theory propounded long before by von Weimarn; namely, that these micellas are small crystals. Nor shall we deal (in spite of very great analogies) with anything relating to soaps, oleates, cholesterol salts, etc.; for, although soaps when in solution give colloidal hydrosols (the work of McBain and his co-workers on this subject is universally known), soaps in the solid state are crystalloids. It would be impossible to discuss them here without being drawn into a study of G. Friedal's smectic bodies, which would take us entirely away from our subject.

Double Refraction of Colloids

In the case of starch, cellulose, etc., we have observed phenomena that can be considered as natural double refraction, since they can be observed in products such as they are elaborated in nature. But there is also an accidental double refraction, which gives rise to the same crystalline appearance. This double refraction manifests itself whenever a liquid or an isotropic body is subjected to forces that can produce a polarisation, either of the molecules of the liquid or of the suspended body. These forces may be mechanical (moving liquids; double refraction of chilled or deformed glass); magnetic (Majorana's phenomenon); or electric (Kerr's phenomenon); or they may be due to the existence of cohesive forces (polarisation at the contact surface of two phases). Not only is this accidental double refraction a very general phenomenon, but it very frequently manifests itself with particular intensity in colloidal products, especially deformed solids such as gelatin, gums, moving liquids (balsams, gelatinous solutions), and also in liquids in a magnetic field (dialysed iron). One is, therefore, led to wonder whether the so-called double refraction of natural colloids may not be the same phenomenon, due, not to a peculiarity in the constitution of these products, but to special conditions in which they are always to be found as a result of their method of formation.

What is the Normal State of Colloids?

As a matter of fact, the only way out of the difficulty is to arrive at some experimental definition of the normal state of colloidal bodies. If we succeed, by several methods, in bringing a solid colloid to a homogeneous state having constant optical properties, we can say that these properties are intrinsic and independent of external forces, and that they are due to the constitution of the molecule (or micella).

U.S. Output of Cement

STATISTICS of hydraulic cements, other than Portland cement, in 1926, which include masonry, natural, and puzzolan cements, as compiled by the United States Bureau of Mines, Department of Commerce, show that the production—2,104,891 barrels—exceeded that of 1925 by nearly 22 per cent. Shipments of these cements from mills in 1926 increased 16 per cent. in quantity and about 11 per cent. in gross value. Stocks at the mills also increased and were about 68 per cent. higher at the end of 1926 than at the end of 1925. These statistics represent the output of 11 plants in 1926, which are located as follows: one each in Alabama, Illinois, Indiana, Kansas, Kentucky, Ohio, and Pennsylvania; and two each in Minnesota and New York. One new plant, in New York, began production of natural cement in 1926.

China Clay Notes and News

New Name for Concrete Blocks

The term "cast stone" is being applied in some quarters to moulded concrete blocks, which have now become such a popular material in building, especially in Cornwall. "Cast stone" was the description originally given to "stone" made by the fusion of silicate rocks and quartz chippings, which was poured into moulds to set. "Cast stone" nowadays differs from this to a great extent, especially in the ingredients used. In parts of the country where there is not available such a cheap aggregate as China Clay sand, the coarser particles of which are quartz crystals, what has up to now been described as artificial stone is composed of crushed natural stone and Portland cement. Cornish artificial stone contains no stones, China Clay sand being wholly used in conjunction with Portland cement. Objection has been taken to the term artificial stone as applied to these concrete blocks, because it implies something derogatory, which the merits, utility, and economy of the material it is considered does not warrant. "Cast stone" certainly has a truer ring about it, a description which may eventually supersede that of artificial applied to their manufactures by certain Cornish firms.

Foreign China Clay Combine

The negotiations for a fusion between the China Clay works in Czecho-Slovakia, all of which are situated in the Carlsbad district have, reports the Prague correspondent of *The Times*, been successfully concluded. An agreement has been signed in Carlsbad by which the Zettlitz kaolin works acquire the entire share capital of the Kaolin Electro-Osmose Co., and of "Akeros." As the Zettlitz works have recently absorbed "Kaolina," a smaller competitor, the new concern will control the whole of the output and sale of Czecho-Slovakian kaolin. The purchase price of the two companies is to be paid partly in cash and partly in shares of the Zettlitz works, which are to increase their share capital from 10 million to 14 million crowns. It is expected that the transaction will involve at least 14 millions of new capital. The China Clay produced at the Zettlitz works is said to be of standard quality and, in addition to its extensive use in the best porcelain factories in Czecho-Slovakia, large quantities of it are exported, notably to Germany. The kaolin of the other works is suitable for only certain kinds of porcelain manufacture. The average annual output of the Zettlitz kaolin works is about 3,600 wagon loads, of "Kaolina" 600 wagon loads, and of the other two companies together 3,000 wagon loads, totalling 7,200 wagon loads. As all the works are to be technically and commercially under the supervision of the Zettlitz people, a considerable increase in production may be anticipated. *The Times* correspondent hazards the opinion that the new concern will exercise a preponderating influence on European porcelain manufacture.

China Clay in Illumination

A little-known use of China Clay is revealed in a note by Sir W. Arbuthnot Lane, the eminent physician, published in a pamphlet called "Sun Worship," issued by the General Electric Co., Ltd., of Kingsway, London, in which the company describe their Osram lamps. Sir W. Arbuthnot Lane states that "many of our educational institutions lack good artificial lighting, and it is in the schools that the eyesight of the nation is either safeguarded or marred. The amount of eye-strain and nervous fatigue in children due to bad lighting is notoriously great. Lack of light is depressing to the human system, but glaring artificial light is still more harmful, especially when the strain is imposed day after day. This applies with equal force to the lighting of warehouses, offices, or the home. The remedy lies in diffusing the intrinsic brilliancy of artificial light sources. The ideal method of effecting this which I have seen is by lamp bulbs that incorporate a diffusing element. This result is obtained by coating the bulbs with a thin, hard, translucent layer of China Clay which effectively screens the filament or light source from the eye. This advantage may be augmented and also rendered more attractive by the addition of the æsthetic charm of colour. Orange, yellow, and flame tints are most popular, the taste of the individual and the decorative

needs of the room suggesting pleasing variations. The mellow beams of candlelight, the warm glow of firelight, and many other effects associated with ease and rest may be provided, with excellent results to health after a day's toil or exhausting sport."

Development of China Clay in Brittany

Mr. W. A. Jenkins (ex-M.P.), of Swansea, who recently attended the Inter-Celtic conference in Brittany, reports that there are at Riec immense deposits of China Clay of a very high standard of quality, and that through the Consortium Breton, which is a parent company controlling several subsidiary companies, the China Clay industry is being very thoroughly developed. Extensive works have been laid out, fitted with the most elaborate and up-to-date machinery, and, with the co-operation of the most highly-trained scientific technical and commercial experts, the industry, which is already remunerative, promises to develop into a highly prosperous concern. It was amazing, he said, to see such wonderful progress and modern plant and machinery installed in an up-to-date works where, until about four years ago, nothing but a marsh was to be seen. The whole plant is driven by electrical power and, except for the manual labour necessary in cutting the clay, all the rest of the process seemed to be worked by machinery. Another striking feature was the wonderful economy in the use of coal and fuel, the heat being condensed and conserved over and over again for different purposes.

China Clay: Census of Production

The Board of Trade is now engaged on the compilation of the Third Census of Production, 1924. In preliminary report No. 27, published in the *Board of Trade Journal*, a statement was given in regard to the products obtained from quarries, other than metalliferous and slate quarries. The returns from clay works indicate that the production in 1924 was as follows:—

	1924.		1907.	
	QUANTITY. TONS.	SELLING VALUE.	QUANTITY. TONS.	SELLING VALUE.
Ball Clay	146,000	128,000	726,000	542,000
China Clay	805,000	1,448,000	—	—
China Stone	51,000	82,000	—	—
Mica Clay	16,000	12,000	25,000	13,000
China Clay and Stone and Mica Clay, not separately distinguished.....	6,000	8,000	—	—
Fireclay	60,000	33,000	38,000	11,000
Other Sorts	461,000	57,000	671,000	87,000

The total production of China, Mica, and Ball Clay as revealed by the Census was 1,024,000. The figures given above represent the quantity and value of each class of quarry products raised for sale in the two years and do not (states the official account), therefore, necessarily express the total production for all purposes, since products used for manufacturing purposes by the firms by whom they were raised are not included.

The American China Clay Trade

Mr. A. B. Searle writes us as follows: "According to a recent Government return, the Americans are rapidly increasing the use of local kaolins instead of the China Clay imported from Cornwall, and last year the American mines supplied more than half the kaolin used. More high grade clay was used last year than ever before, and, notwithstanding adverse freights from southern clay areas to northern markets, the quantity of clay used for pottery, paper, and for various filling purposes continues to increase. The sales of American kaolin increased 18 per cent. and those of imported China Clay only 6 per cent. The Southern States—especially Georgia—produce more than 80 per cent. of the total American kaolin. The imports of China Clay from England constituted 81 per cent. of the total clay imported last year, and were the largest ever recorded. The average price was also 21 cents higher than in previous years. There is thus the curious state of affairs that, although the Americans are using a larger proportion of local clays than ever, the trade is increasing to such an extent that the import of Cornish China Clay also constitutes a record."

Shipping and Export News of the Month

We give herewith latest particulars relating to arrivals and sailings of ships engaged in the China Clay trade, at the principal British clay ports. Registered exports of China Clay, with countries of destination, and other shipping and export matters are dealt with.

Fowey Shipping—November, 1927

Arrived.	Name.	Sailed.	Destination.
November 1,	s.s. <i>Marta</i>	November 4,	Gothenburg
November 1,	s.s. <i>Beechfield</i>	November 3,	Plymouth
November 2,	s.s. <i>Gronant Rose</i>	November 8,	Weston Point
November 2,	s.v. <i>Rose</i>	November 12,	Granton
November 3,	s.v. <i>Kate</i>	November 4,	Charlestown
November 3,	s.s. <i>Mersey</i>	November 5,	Ridham
November 3,	s.s. <i>Primrose</i>	November 9,	Weston Point
November 4,	s.s. <i>Teesbridge</i>	November 9,	Philadelphia
November 5,	s.s. <i>Holby</i>	November 15,	Norfolk, U.S.A.
November 5,	m.v. <i>Conrad Luhring</i> ..	November 13,	Gothenburg
November 5,	s.s. <i>Goole</i>	November 8,	Gravesend
November 5,	s.s. <i>Sturdee Rose</i>	November 9,	Runcorn
November 6,	s.s. <i>Pengam</i>	November 15,	Passages
November 6,	s.s. <i>Mercurius</i>	November 9,	Gothenburg
November 7,	s.s. <i>Trellborg</i>	November 11,	Sarpsborg
November 7,	m.v. <i>Regina</i>	November 8,	Plymouth
November 8,	s.s. <i>Joffre Rose</i>	November 11,	Rouen
November 8,	s.s. <i>Pentoway</i>	November 19,	Philadelphia
November 8,	s.s. <i>Gouwestroom</i>	November 15,	Amsterdam
November 8,	m.v. <i>Lyhner</i>	November 9,	Plymouth
November 9,	s.s. <i>Grosvenor</i>	November 12,	Lancaster
November 10,	s.s. <i>Breme</i>	November 12,	Bergen
November 10,	s.s. <i>Taycraig</i>	November 12,	Weston Point
November 10,	s.s. <i>Hayle</i>	November 14,	Manchester
November 10,	s.s. <i>Mersey</i>	November 12,	Ridham
November 11,	m.v. <i>Lyhner</i>	November 12,	Plymouth
November 11,	s.s. <i>Kentish Coast</i>	November 15,	Liverpool
November 12,	s.s. <i>Kilstroon</i>	November 18,	Amsterdam
November 12,	s.s. <i>Ingleby</i>	November 23,	Portland Me.
November 12,	m.v. <i>Marcie</i>	November 18,	Hamburg
November 12,	s.s. <i>Brier Rose</i>	November 17,	Fleetwood
November 14,	m.s. <i>Mindoro</i>	November 25,	Boston
November 14,	s.s. <i>Daguy</i>	November 18,	Hamburg
November 14,	s.s. <i>Dorrien Rose</i>	November 17,	Antwerp
November 14,	s.s. <i>Haig Rose</i>	November 22,	Preston
November 14,	m.v. <i>Intrepido</i>	November 23,	Genoa
November 14,	s.s. <i>Newton Elm</i>	November 29,	Bombay
November 16,	s.s. <i>Patrick</i>	November 21,	Hamburg
November 16,	s.v. <i>Lady Jean</i>	November 24,	Aylesford
November 17,	s.s. <i>Wild Rose</i>	November 22,	Runcorn
November 17,	s.s. <i>Pansy</i>	November 23,	Weston Point
November 17,	s.s. <i>Brynawel</i>	November 22,	Antwerp
November 18,	s.s. <i>Blush Rose</i>	November 23,	Runcorn
November 19,	s.s. <i>Jellicoe Rose</i>	November 26,	Brussels
November 19,	s.v. <i>Solon</i>	November 23,	Charlestown
November 19,	m.v. <i>Carina</i>	November 26,	Drammen
November 20,	s.s. <i>Erindring</i>	November 26,	Norrköping
November 20,	m.v. <i>Johannes</i>	November 26,	Odense
November 20,	s.s. <i>Mersey</i>	November 23,	Ridham
November 22,	s.s. <i>Belvedere</i>	November 25,	Passages
November 22,	s.s. <i>Pregel</i>	November 26,	Stettin
November 22,	s.s. <i>Stanwell</i>	November 24,	Charlestown
November 23,	s.s. <i>Primrose</i>	November 29,	Preston
November 24,	s.v. <i>Raymond</i>	*	Terneuzen
November 24,	s.v. <i>Oxvgen</i>	*	London
November 25,	s.v. <i>Ella Eff</i>	December 1,	Fredrikshald
November 25,	s.s. <i>Guelder Rose</i>	November 30,	Brussels
November 25,	s.s. <i>Amstilstroom</i>	November 30,	Amsterdam
November 25,	s.s. <i>Glasgow Marn</i>	*	Philadelphia
November 25,	s.s. <i>Wearbridge</i>	December 4,	Portland Me.
November 25,	s.s. <i>Gouwestroom</i>	December 1,	Amsterdam
November 25,	m.v. <i>Corrie</i>	December 2,	Gravelines
November 25,	s.v. <i>Jane Banks</i>	*	Runcorn
November 25,	m.v. <i>Advance</i>	December 2,	Barcelona
November 26,	s.s. <i>Joffre Rose</i>	December 1,	Preston
November 26,	s.s. <i>Ambleside</i>	December 3,	Antwerp
November 27,	s.s. <i>Gronant Rose</i>	December 3,	Garston
November 27,	s.s. <i>Scartho</i>	December 3,	Karlskrona
November 27,	s.s. <i>Brier Rose</i>	December 1,	Fleetwood
November 28,	s.s. <i>Dunvegan</i>	December 3,	Glasgow Dock
November 28,	s.s. <i>Northdale</i>	*	Antwerp
November 29,	s.v. <i>Rossing</i>	*	Granton
November 29,	s.s. <i>Kate Grammerstorf</i> ..	*	Harburg
November 30,	s.s. <i>Artificer</i>	*	Rouen
November 30,	s.s. <i>Haig Rose</i>	*	Weston Point
November 30,	m.v. <i>Amazon</i>	December 2,	Pentewan
November 30,	s.v. <i>Clytia</i>	*	Charlestown

* Signifies "In Port."

Charlestown Shipping—November, 1927

Date.	Vessel.	Destination.
November 4.....	<i>Gauntlett</i>	Kirkcaldy
November 7.....	<i>Kate</i>	Runcorn
November 8.....	s.s. <i>Glencregagh</i>	Gravesend
November 10.....	s.s. <i>Royal Firth</i>	Sunderland
November 12.....	s.s. <i>Walnut</i>	Weston Point
November 12.....	s.s. <i>Jolly Norman</i>	Tayport
November 12.....	s.s. <i>Ribblebank</i>	Glasgow
November 18.....	s.s. <i>Magrix</i>	Aberdeen
November 23.....	s.s. <i>Christiana</i>	Preston
November 24.....	s.s. <i>Overton</i>	Leith
November 25.....	s.s. <i>Dinowic</i>	Gravesend
November 25.....	s.s. <i>Stanwell</i>	Brussels
November 25.....	<i>Rylands</i>	Thames
November 25.....	<i>B.25</i>	Nantes
November 26.....	s.s. <i>Miriam Thomas</i>	Fleetwood
November 26.....	<i>Tarragona</i>	Rochester
November 28.....	<i>Alert</i>	Runcorn
November 29.....	s.s. <i>Crossbill</i>	Gravesend

Par Harbour Shipping—November, 1927

Arrivals

Date.	Vessel.	From
November 3, s.s.	<i>Christina</i>	Malpas
November 4, s.v.	<i>Falken</i>	Fowey
November 5, s.s.	<i>Eastoft</i>	Torquay
November 5, s.v.	<i>Emily Warbrick</i>	Falmouth
November 7, s.s.	<i>Breme</i>	Cardiff
November 8, s.s.	<i>Jolly Angela</i>	Glasgow
November 10, s.s.	<i>Knowlsgrove</i>	Truro
November 11, s.s.	<i>Vilvorde</i>	Plymouth
November 11, M.V.	<i>Regina</i>	Plymouth
November 11, s.s.	<i>Rosalie</i>	London
November 12, s.v.	<i>Scone</i>	Plymouth
November 13, M.V.	<i>Capable</i>	Bridport
November 13, s.v.	<i>My Lady</i>	Goole
November 15, s.s.	<i>Magrix</i>	Plymouth
November 19, M.V.	<i>Amazon</i>	Plymouth
November 19, s.v.	<i>Mount Blairy</i>	Falmouth
November 19, s.v.	<i>Flying Foam</i>	Mevagissey
November 20, s.v.	<i>Ella Eff</i>	Riverselle
November 22, M.V.	<i>Kate</i>	Plymouth
November 23, s.v.	<i>Clymping</i>	Truro
November 23, M.V.	<i>Advance</i>	Stockholm
November 26, s.s.	<i>Eastoft</i>	Blyth
November 26, s.s.	<i>Briaceen</i>	Middlesbrough
November 26, s.s.	<i>Robrix</i>	Teignmouth
November 29, M.V.	<i>Regina</i>	Plymouth
November 30, s.v.	<i>Greenhithe</i>	Exeter

Sailings		
Date.	Vessel.	Destination.
November 5, s.s.	<i>Dinorwic</i>	Rouen
November 5, s.v.	<i>Penryn</i>	London
November 5, s.v.	<i>Lady Agnes</i>	Goole
November 6, M.V.	<i>Kate</i>	Greenhithe
November 7, s.s.	<i>Horsham</i>	Terneuzen
November 7, s.s.	<i>Christina</i>	Manchester
November 9, s.v.	<i>Falken</i>	Fredrikshald
November 9, s.s.	<i>Eastoft</i>	Rouen
November 9, s.s.	<i>Jolly Angela</i>	Northfleet
November 10, s.s.	<i>Breme</i>	Fowey
November 11, s.s.	<i>Knowlsgrove</i>	London
November 12, s.v.	<i>Duchess</i>	London
November 12, s.v.	<i>Emily Warbrick</i>	Runcorn
November 12, s.s.	<i>Vilvorde</i>	Brussels
November 14, s.s.	<i>Rosalie</i>	Teignmouth
November 14, M.V.	<i>Capable</i>	Rochester
November 15, M.V.	<i>Regina</i>	Plymouth
November 15, s.s.	<i>Magrix</i>	Charlestown
November 19, s.v.	<i>Scone</i>	Rochester
November 23, s.v.	<i>My Lady</i>	Runcorn
November 23, M.V.	<i>Kate</i>	Plymouth
November 24, s.v.	<i>Ella Eff</i>	Fowey
November 25, M.V.	<i>Advance</i>	Fowey
November 29, s.v.	<i>Flying Foam</i>	Runcorn
November 29, s.s.	<i>Robrix</i>	Kirkcaldy
November 30, M.V.	<i>Amazon</i>	Fowey
November 30, s.s.	<i>Eastoft</i>	Gravesend

Dyestuffs Monthly Supplement

Published in the second issue of "The Chemical Age" each month

Communications relating to editorial matter for the Dyestuffs Monthly Supplement should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Advertisement matter, subscriptions, etc., should be sent to the Manager. The Supplement is devoted to the interests of both manufacturers and users of dyestuffs, and contributions will be welcomed.

New B.D.C. Colours

THE latest addition by the British Dyestuffs Corporation to their range of colours for cellulose acetate silk is Duranol Blue R Paste. It gives full reddish blue shades of good fastness to light and excellent fastness to washing. It possesses very good fastness to rubbing and hot pressing, and will be found suitable as a basis for royal and navy shades on all forms of cellulose acetate materials. It can be used in combination with other Duranol and Ionamine colours. It is dyed, in the manner usual for Duranol colours, at a temperature of 75° to 85° C. from a bath containing (if desired) Turkey Red Oil or other soluble oil. As regards dyeing and fastness properties, it is stated that its affinity is good, its behaviour to washing excellent, to mineral acids poor, to scrooping very good, to alkali very good, to rubbing very good, to hot pressing very good, and to light good to very good. In the descriptive leaflet issued 3 per cent. Duranol Blue R Paste is shown on cellulose acetate piece, and the 10 per cent. Paste on cellulose acetate yarn.

Thionine Blue G.O. has been added to the B.D.C. range of basic dyestuffs. It is suitable for dyeing cotton piece on a discharged tannin mordant and gives very good white effects. It withstands the action of reducing agents and is especially suited to the colouring of rongalite (formosul) or tin discharges on dischargeable direct dyed grounds. It also finds considerable use in the production of blue resists under Aniline Black. In the discharge and resist styles, it is superior to the Methylene Blues, since the shade of Thionine Blue G.O. is much less affected in the process. It may be used for direct printing with tannic acid, using the method customary for basic colours. Its solubility and fastness to light and washing are described as good, and its behaviour to water as very good.

Forecast of Fashionable Autumn Shades

THE seasonal forecasts of fashionable shades issued by the British Dyestuffs Corporation have been so successful and the demand for copies so great that the Corporation has decided to make their regular issue a permanent feature of the business. A forecast of 10 fashionable shades for autumn, 1927, has just been published, the patterns being dyed on worsted and the colour combinations used being standard in the trade. The shades are as follows: Angelica (Lissamine Fast Yellow 2G and Alizarine Delphinol BDN or Alizarine Ultra Blue B); Melon (Lissamine Fast Yellow 2G and Red BG), Mimosa being of the same components; Charleston Rose (Lissamine Fast Red BG and Fast Acid Violet 2R); Nutmeg, Dove, Shagreen, Moorland Purple and Etruscan Red (all made up of varying proportions of Lissamine Fast Yellow 2G and Red BG, together with Alizarine Delphinol BDN or Alizarine Ultra Blue B); and Biarritz Blue (Alizarine Delphinol BDN or Alizarine Ultra Blue B with Lissamine Fast Red BG).

Colours on Vegetable Tanned Leather

A NEW pattern card, illustrating acid and basic colours on vegetable tanned leathers has also been issued by the Corporation. The patterns are prefaced by an account of the dyeing of these leathers, which includes accounts of tray, paddle, and drum dyeing and of the dyeing process. Basic dyestuffs, while rather more

difficult to dye level than acid dyestuffs, and less fast to rubbing, are sometimes indispensable because of brightness and greater depth of shade obtainable. They are often employed for topping acid colours. Of the 72 patterns on the card (all dyed on sumac tanned skivers), 54 are dyed with acid dyestuffs (applied with formic acid) and 18 with basic (applied with acetic acid). It is customary, when using basic dyestuffs, to give the skins a preliminary working in tartar emetic in order to fix loose tannin, while titanium salts may also be used as fixing agents.

For the production of shades other than those illustrated on the card (e.g., mode shades) a list of suitable combinations is suggested.

Dyestuffs Licenses for June

THE following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during June, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee. The total number of applications received during the month was 563, of which 457 were from merchants or importers. To these should be added 23 cases outstanding on May 31, making a total for the month of 586. These were dealt with as follows: granted, 492 (of which 462 were dealt with within 7 days of receipt); referred to British makers of similar products, 64 (of which 46 were dealt with within 7 days of receipt); referred to Reparation supplies available, 4 (all dealt with within 2 days of receipt); outstanding on June 30, 1927, 26. Of the total of 586 applications received 512, or 87 per cent., were dealt with within 7 days of receipt.

The European Situation: An American View

THE attitude of the United States towards the developments which have been occurring in regard to dyestuff production in Europe is naturally of very great importance, in view of the intense activity which prevails in the United States dyestuff industry. In a recent issue of *Chemicals* the situation is reviewed and discussed in very plain terms. In the first place, the possibility of an Anglo-German dye pact and its effect on the American dye industry are discussed. The present position, of course, seems to be that any such arrangement which is made will extend far beyond dyestuffs. Nevertheless, the American comment on this aspect of the matter is interesting: "It is generally surmised that any agreement will have the effect of reducing the sales prices of both British and German dyestuffs put into foreign trade."

A Tribute to British Industry

THEN follows a pat on the back for British dyemakers: "The fact is that the British dyemakers have succeeded in putting out a growing proportion of satisfactory 'fast' colours, have increased the number of dyes produced in Great Britain, and have really gained unusual results in perfecting dyestuffs for use with artificial silks. This is 'getting home' at the I.G., which, in keeping with its customary practice, is seeking a working agreement with a rival which it cannot put out of business. It is also a fact that although British consumers of dyestuffs are paying higher prices just now than are paid to their foreign rivals, reductions in price are being made continuously and persistently, and with the recent consolidations in Great Britain—notably the Imperial Chemical Industries—there

appear to be indications of still more drastic reductions." This fact is supported in the American article by a reference to the recent decision of the Dyestuffs Licensing Committee to reduce the price factor from two-and-one-half times to twice the pre-war. Further, it is thought that this reduction of 20 per cent. will result in an equivalent reduction in the prices of British dye products.

The American Home Trade

EVEN as regards their own home trade the Americans apparently feel some uneasiness—in view of a possible Anglo-German pact. "Of course, we have the ameliorating panacea (?) of the so-called 'flexible provisions' of the tariff act to fall back upon, but there seems to be a general opinion that this barrier will not be sufficient and that despite all the artificial wire fences that can be erected by Congress and by the President it might prove impossible to prevent an influx of the cheaper foreign dyes, thus forcing down the prices of American products." What is also in their minds is the fact that as dyestuff production is but a small part of the enormous activity of the I.G., the latter might be able to sell its 1,100 dyestuffs at a small loss providing that it was assured of the acquisition of new or once-held markets.

Far Eastern Markets

FURTHERMORE, the question of Far Eastern markets must be considered. The best markets for the American producer of dyestuffs are India, China, and Japan. "The Germans practically lost these markets during the war, but have since regained them in part; Great Britain sought to control them after the German goods had been shut out, and endeavoured to make Hongkong and Shanghai big dye distribution centres, but this did not work out as anticipated, and American products still lead in the Orient. But, with Germany and Great Britain working together to recapture the markets, with British revenue and consular officials 'on the job,' as they usually are, who shall say what the result would be of an intensive campaign to popularise Anglo-German products at prices 20 per cent. less than those quoted to-day?" It is clear from the last quotation that Americans have a much greater respect for the British Consular service than some of our Jeremiahs would have us believe.

Position of German Dye Users

A RECENT report from an American consul in Germany states that the formation of the I.G. has not benefited German consumers of its products. In fact, with reference to prices the consumers are at a disadvantage owing to an over increase of German as compared to world market prices. For this reason certain German dyers are said to have started to produce in their own plants a part of their dyes from imported intermediates. The values of imported dyes from Switzerland into Germany have shown a steady increase. German imports of coal tar dyes have reached an unprecedented height; in 1926 imports were 3,600 tons valued at 17,364,000 marks. In pre-war times Germany exported 85 per cent. of production, to-day 66½ per cent. is exported from a production of 56,000 tons, compared to 129,000 tons pre-war production.

Dye Fastness

THE question of the need for standard methods of determining and specifying the fastness of dyes receives very interesting treatment in the course of an article contributed to the *Manchester Guardian Commercial* by Mr. F. Scholefield, the chairman of the British Committee on Fastness Standardisation. In a discussion of the history of the action taken in other countries, it is pointed out that a committee was set up in Germany as long ago as 1911 with the object of preparing such standards. This body, the "Echtheits-Kommission," published its third report

in 1926. The standard tests so far issued concern thirteen fastness properties of dyes on cotton, fifteen on wool, and eleven on silk. Five grades of fastness are adopted.

Position in the United States

AS regards the United States, Mr. Scholefield states that the work of fastness standardisation has been undertaken by the American Association of Textile Chemists and Colorists, and a research committee is collaborating with the Bureau of Standards. The United States workers have endeavoured to set up standards of fastness as regards cotton, wool, silk, and artificial silk. The classification and tests adopted are somewhat different from the German ones. "The work on standards of fastness to light is proceeding in conjunction with the Bureau of Standards; more than a thousand dyed samples have been exposed, each in nine different ways, but the report on the results is not yet issued. Also, attempts are being made to produce a suitable lamp which can be used under standard conditions to replace exposure to daylight.

British Work on Fastness

MR. SCHOLEFIELD'S account of the action which has been taken in this country is of special interest, not only in giving a valuable summary, but because it indicates that the problems are being tackled from a broad, scientific standpoint. The Society of Dyers and Colourists has succeeded in getting together a committee which is completely representative of every scientific, technical, and commercial aspect of the matter. A great deal of work on fastness has been done in this country in the last few years—for example by the British Silk Research Association and the British Research Association for the Woollen and Worsted Industries. As still more and more comes to be known on the subject, the great complexity of some of the problems presented becomes obvious. For example, the measurement of the degree of fading may be complicated by a change in colour—a pure blue, for example, fading to a violet. This particular point is undergoing independent investigation by the Wool and Cotton Research Associations.

Possibilities of International Co-operation

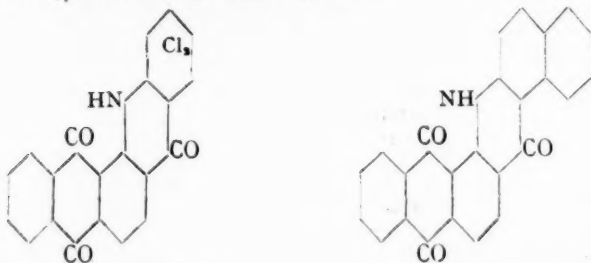
"How far," asks Mr. Scholefield, "is it possible to obtain agreement internationally? To begin with, there is at least the expression by responsible persons in England, Germany, and the United States of the desirability of uniformity. Mr. Ernest Hickson, speaking recently at Bradford, said that the Society [of Dyers and Colourists] felt strongly that they should work in co-operation with other bodies engaged on the same problem. They felt it was most desirable, if possible, to come to an agreement for international standardisation tests. They were assured the German Commission would be very glad indeed to work with the Society. . . .

"Professor L. A. Olney, of the American Committee, welcomes the co-operation of the British Committee. The relations between the two bodies are most cordial, and there are already indications that in regard to light fastness no standards will be put forward by either body until opportunity has been afforded for the consideration of the work and proposals of the other. Professor W. M. Gardner says that 'it is high time some definite standards were fixed to enable dyers on the one hand and textile merchants, as representing the public, on the other, to know precisely what degree of fastness can be obtained for any particular shade on their goods. For shades of good fastness standards could then be established which could be reproduced anywhere.' It is surely desirable that such standards should be valid throughout the world; with goodwill the textile chemists and colourists of these countries ought to be able to ensure that universality."

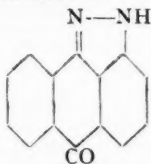
Some Recent Tendencies in Dyestuffs Chemistry

New Derivatives and New Ring Structures

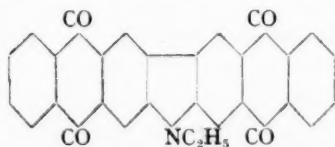
ONE of the lines of development of dyestuffs chemistry in the last few years has been in the direction of a search for new ring structures or new combinations of known ring systems. The ever-increasing demand for fast colours, which are chiefly to be found in the class of anthraquinone vat dyes, has directed this search for new ring structures to the building up, on the anthraquinone molecule as basis, of various heterocyclic rings. This procedure, which was already in evidence before 1914, has had several distinct successes. In two of these, Red Violet RRN and Red BN:—



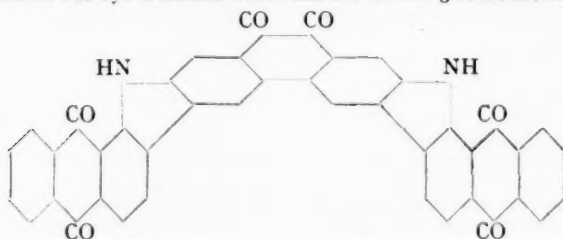
the acridone and anthraquinone ring systems are fused. Anthraquinone-azines, -thiazines, -thiazoles and -thio-xanthenes are further examples of the same idea, though in these cases no commercially useful dyes have resulted. Another notable example is Pyrazolanthrone Yellow, a dye obtained by potash fusion of pyrazolanthrone:—



The fusion of the anthraquinone with the carbazole molecule yielded, some years ago, the exceptionally fast Hydron Yellow G:—



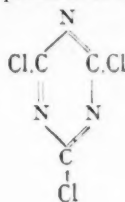
In this instance the anthraquinone structure was imposed on that of carbazole by condensing phthalic anhydride with ethyl carbazole. (It is remarkable that the use of carbazole itself in place of its ethyl derivative yields a useless pale yellow dye of no fastness.) The opposite procedure of building up the carbazole nucleus on that of anthraquinone can be accomplished in several ways. One of these consists in acting on dianthraquinonylamines with aluminium chloride, and an example of this method forms the subject of a German patent application of this year. Dibromophenanthraquinone is condensed with two molecules of α -aminoanthraquinone, and on heating the product with aluminium chloride a fast reddish brown vat dye is formed which has the following constitution:—



Incidentally, this case offers proof of the endeavours which are being made to utilise phenanthraquinone for dyestuffs, as does also a German patent of last year on the preparation

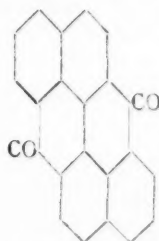
of mordant dyes of the phenanthraquinone series. These are aminohydroxyphenanthraquinones which dye chromed wool in olive-green to black shades.

An entirely new ring structure is made use of, in conjunction with anthraquinone derivatives, for the preparation of a new series of vat dyes by the Society of Chemical Industry of Basle. These are condensation products of cyanuric chloride:—



with aminoanthraquinones, and a large number of examples have been worked out giving vat dyes of a wide range of shades.

As regards new ring structures, the outstanding example of this line of progress is the series of perylenequinone vat dyes, of which so much has been heard in recent years. Another instance appears in a German patent of this year, in which the basic ring structure is that of the so-called anthranthrone:—



This substance was first prepared in 1914 by Kalb from dinaphthyl-2 : 2'-dicarboxylic acid or the 8 : 8'-dicarboxylic acid by a simple dehydration with concentrated sulphuric acid. Anthranthrone and its derivatives are capable of being vatted and of dyeing the textile fibres. But the parent substance seems to have too little affinity to be of much practical use (it gives yellowish orange shades on cotton) and the obvious procedure has been followed of promoting affinity by chlorination and bromination. This treatment at the same time intensifies the shade, so that orange to orange-red vat dyes are obtained, for which brilliance and great fastness are claimed.

The amount of work carried out on the lines described above by the various dyestuff firms, especially in Germany and Switzerland, is very great. As a matter of routine, probably almost all of it becomes embodied in the patent literature, and the extent of this may be realised by the perusal of such a work as Truttwin's *Die Kuppenfarbstoffe*. The proportion of successful dyestuffs obtained on these lines has so far been small, but one success makes up for many failures, and the search continues. Work of this empirical nature implies, of course, the absence of any suggestive hypothesis such as Witt's chromophore theory, the inspiration of much fruitful research in the earlier periods of growth of the dyestuffs industry.

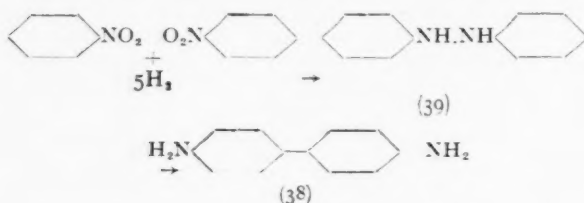
New American Food Dye Approved

A NEW green food dye, Fast Green FCF, has been added to the list of coal-tar colours that will be certified by the United States Department of Agriculture under existing certification regulations. Before recommending its admission to the list of permitted coal-tar food dyes, the Bureau of Chemistry, which is charged with the enforcement of the Federal Food and Drugs Act, subjected the new green colour to rigid chemical and physiological tests to prove its purity and harmlessness to health. Only dyes which are thus shown to be absolutely safe are placed on the list of colours accepted by the U.S. Government for certification and use.

Basic Intermediates for Dyestuffs : No. IX.—Benzidine, Tolidine and Dianisidine

By "Consultant"

THE use of benzidine for the production of disazo dyes dates from the earlier stages of the dyestuffs industry, but it has proved so successful an intermediate and offers such a scope for the production of a large variety of shades that its use has increased steadily, until at the present time it constitutes one of the most important intermediates of the industry. Its preparation involves two stages, which can, as is usual with any such preparation, be accomplished in a variety of different ways. The two stages comprise the reduction of nitrobenzene to hydrazobenzene and the rearrangement of this compound with the formation of benzidine (38).

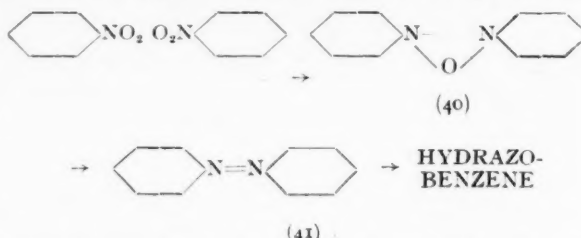


Chemically speaking, the reduction of the nitro compound to hydrazobenzene (sym-diphenylhydrazine) is the more difficult of the two operations. In the older plant for the production of this substance stoneware or heavily enamelled vessels were insisted upon, since it has been stated that the use of an unprotected iron vessel materially lessens the yield. That this is so seems problematical, in view of the fact that the reduction can be accomplished by iron borings. The process, where zinc is used for the reduction, is comparatively simple. The nitrobenzene (41 cwt.) is run into a suitable vessel fitted with a powerful stirrer, reflux condenser, small manholes for the addition of the zinc dust and a jacket for temperature control. Spirit (20 galls.) and water (50 galls.) are then added (the spirit enables the reduction to proceed more smoothly), followed by sodium hydroxide solution of 35 per cent. strength (120 galls.). The reaction mixture is stirred together for a few minutes, and is then ready for the addition of the zinc dust, which is fed in at intervals through the manhole, at such a rate that the reaction mixture is kept in a state of steady ebullition. For the quantities mentioned above, about 3½ cwt. of zinc dust is required, the addition of which takes from 3 to 3½ hours. If the dust is of good quality the reaction mixture will, by this time, have been completely decolourised; if still yellow the reduction is completed by the addition of further water and zinc dust until decolorisation is complete. The yellow colour, it may be noted, is not the colour of unchanged nitrobenzene, but rather that of the sodium derivative of nitrothiophene, which occurs in the commercial product.

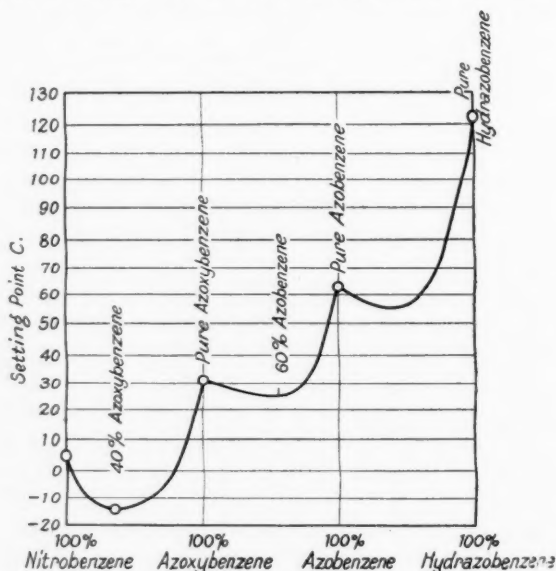
The spirit is now blown off with steam, the residual sludge allowed to cool somewhat, and then run on to vibrating screens (of 60 mesh). Such a screen retains the comparatively large crystals of hydrazobenzene, but allows the fine particles of zinc oxide to pass through, thus effecting an easy and rapid separation. Washing with water is the only treatment required before the hydrazobenzene is converted to benzidine.

The size of the zinc dust is, of course, an important factor in the production of a high yield of good quality product. If the dust is too small the reduction proceeds explosively, and has given rise to several accidents; if too large, the particles are not oxidised sufficiently rapidly, and become embedded in the interior of crystals of hydrazobenzene. Electrolytic spongy zinc is stated to be superior to any grade of zinc dust for the reduction of nitrobenzene, but its use has not yet become common. The zinc, which forms an important item with regard to the cost of the process, is recovered in the form of the oxide. This is easy enough where screens are used for the separation of hydrazobenzene and oxide, but in the older process where the whole batch was run into a mixture of ice and dilute hydrochloric acid, it was a more difficult matter.

The use of iron borings as a reducing agent is obviously much cheaper than the use of zinc, whilst in addition the reduction affords an almost unique case of a large scale operation which can be stopped at definite stages according to the amount of reagent used. The three compounds which are successively produced in the reaction—azoxybenzene (40), azobenzene (41), and hydrazobenzene can be produced in



quantity according to the amount of iron used. The procedure is as follows. Nitrobenzene (2 cwt.) and iron borings (15 cwt.) are stirred together (it will be noticed that no spirit is used) at a temperature of 80° to 90° C., and sodium hydroxide solution of 60 per cent. strength (16 cwt.) is run in at such a rate that the temperature remains between 110° and 120° C. Most powerful stirring is necessary, and the time required for the reduction to the azoxy compound differs according to the size of the iron borings used—the reaction being essentially a surface one. The progress of the reaction is followed by means of the setting point of the product, which is sampled at definite intervals. The setting point curve for the whole process is given in the figure below. The setting point of the mixture



at this stage reaches a minimum (−13° C.) when 40 per cent. of the azoxy compound has been formed, and reaches +31° C., when the reduction to the azoxy compound is complete. At this point a further quantity of iron borings are added (5 cwt.) together with caustic soda solution (60 per cent., 6 cwt.). Reduction proceeds to the azo compound and is complete when the setting point reaches 63° C. The last stage—the reduction to hydrazobenzene—is accomplished by the addition of a further quantity of iron and caustic soda—in quantity equal to the previous addition. The reduction proceeds to the hydrazo compound, but the stage is only accomplished with difficulty, since very stable emulsions are often formed by the

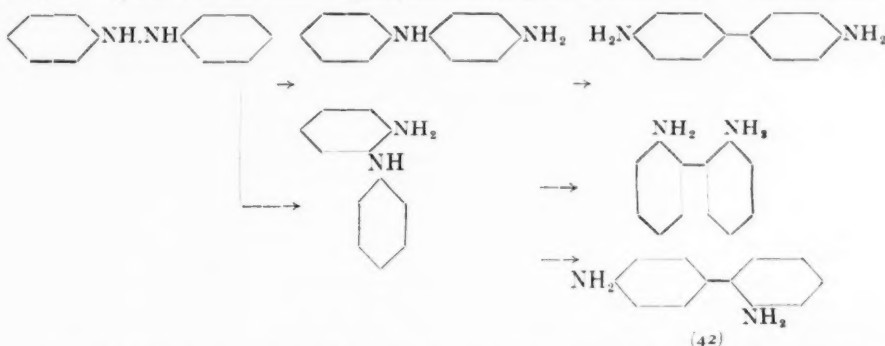
powerful stirring which is necessary, whilst there is also a tendency towards the formation of aniline. This latter can be prevented by lowering the temperature to 80° C., an expedient which is, however, attended by the separation of solid hydrazobenzene. Benzene is usually added to counteract this.

An ingenious method for the reduction of nitrobenzene is that which utilises the sodium amalgam from the cathode compartment of the Castner-Kellner cell. Nitrobenzene is mixed with pyridine and water, and the amalgam is forced mechanically through this mixture, which is powerfully stirred. The mechanical difficulties of this process have yet to be satisfactorily overcome.

The conversion of the hydrazobenzene to benzidine is a comparatively simple operation, and involves the well-known migrations which all *N*-substituted derivatives of aniline show. At the same time as the main reaction proceeds, as shown in the top line of the scheme, side reactions involving migrations to the ortho position take place to some extent, diphenylene

liquor is boiled and the benzidine precipitated as sulphate. The free base when required can be obtained by the action of caustic soda solution on the sulphate. The yield of crude benzidine is about 50 per cent. of the weight of nitrobenzene used; about 10 per cent. of the hydrazobenzene is lost as diphenylene, which owing to its soluble sulphate is readily separated from the benzidine. Further purification of benzidine is undoubtedly best accomplished by distillation in vacuo, less than 1 mm. pressure giving the best results.

Tolidine is prepared from *o*-nitrotoluene in an exactly similar manner, but the tendency to ortho-migration is rather less pronounced, so that the final product is often much purer than is usually the case with benzidine. Dianisidine requires as a starting point *o*-nitroanisole, which can be obtained by the methylation of *o*-nitrophenol with methyl sulphate, or alternatively by the action of methyl alcohol and caustic soda on *o*-chloronitrobenzene. The reduction to hydrazoanisole resembles the foregoing processes so closely that a detailed description is unnecessary. The zinc dust and spirit method



(42) being the compound which is formed to the greatest extent. In actual practice the hydrazobenzene is suspended in twice its weight of water at 35° to 40° C., and a slow stream of hydrochloric acid run in at such a rate that there is always an acid reaction. When the reaction is permanently acid the

is more successful than the method involving the use of iron, and the hydrazo compound is not separated from the zinc oxide sludge, but the whole is run straightway into hydrochloric acid and allowed to stand several days, during which the required rearrangement takes place.

The Dyestuff Industry : National and International Views A General Survey

The monograph on the chemical industry, submitted to committee B of the Preparatory Committee for the International Economic Conference of the League of Nations by the Association of British Chemical Manufacturers, contains some important considerations regarding dyestuffs, which are reprinted below.

THE manufacture of aniline dyes and of fine chemicals are intensely scientific industries. In none of the other branches of chemical industry is the proportion of scientifically trained chemists and engineers to the rest of the workers so great. In no other section is there so large a number of separate processes each requiring meticulous scientific control by minds trained in science and skilled in the application of that knowledge. The foundation of chemical industry is research, pursued for the discovery of new products, improvements in manufacturing processes, and utilisation of by-products. Where an army of research workers is constantly contributing to scientific and technical knowledge it is inevitable that the industry in which they operate should gradually and continuously expand and extend its scope. During the 70 years of its life, the aniline dye industry has abundantly demonstrated this. It is the parent of the synthetic perfumes, pharmaceutical products, photographic chemicals, and even of the synthetic ammonia and methanol industries.

It is, therefore, self-evident that the manufacture of aniline dyes is of first importance not only of itself but also by virtue of its potentiality as a research centre. Nowhere else in industry is such a variety of scope and opportunity presented for the trained chemist. On the other hand, no other industry offers like facilities for the training of the post-graduate chemist. It has become an axiom that the future of the chemical industry largely depends upon its ability to maintain and develop its technical and scientific sides. Probably it is not an exaggeration to say that the dependence is upon

the ability of the aniline dye industry to do so. Such a view would find support in the very striking examples of chemical industrial achievements typified in the synthesis of ammonia and of methanol by the application of the principle of high pressure catalytic reaction of gases worked out as a side line by the dyestuffs industry.

Varied Activities of Dyestuffs Chemists

Development of technique is imperative not only in the manufacture of dyes but also in their marketing. The application of dyestuffs to fabrics, yarns, leather and the host of other materials to be dyed follows scientific principles, and its operations involve scientific method and skilled control. The dyehouse laboratories attached to dye factories are virtually the fountains from which spring the best methods of applying their products. In them a vast amount of incessant research goes on. They are, indeed, hardly less important than the manufacturing research departments. Their work is of an extremely catholic nature—they include amongst their functions the control of works processes, and standardisation of products—and they are staffed with chemists of varied denominations: tinctorial, textile, biological, and physical chemists.

An excellent example of the type of service rendered by such a department is the evolution of suitable methods and processes for the dyeing of cellulose acetate silk—a new artificial fibre not amenable to the methods and processes in general use for other fibres. In this instance new methods of applying existing dyestuffs were discovered in the dyeing laboratories

of dye factories, which were also the source of information leading to the discovery of entirely new groups of dyes peculiarly suited to this purpose.

Too much emphasis cannot be laid on the enormous expenditure involved in chemical industry in the early stages of development in new processes and more especially in proving their usefulness in their varied applications. Even then the country in which the early discoveries are made may not reap the benefit. Perkin's discovery in England of Mauvein was the foundation of the synthetic organic dyestuffs industry, but the industry was first fully developed in Germany, and finally Germany was responsible for producing nearly 90 per cent. of the world's requirements. This example is used in the German monograph to show that "this concentration in a single country was of decisive importance for the development of this industry into a remunerative large-scale industry." The argument is not conclusive, first because the Swiss dyestuffs industry which grew up side by side with the German industry was (although much smaller) remunerative, and secondly, it does not necessarily apply to other industries. It cannot be contended, for example, that because in England and America as well as in Germany there are synthetic ammonia industries none can succeed because the work is not concentrated in one country.

It probably is only sound when applied to goods of which the money value per unit of weight is high. Moreover, a contemplation of the 1,500 different dyestuffs which have been produced in Germany may lead to an erroneous value being given to the argument which has been adduced. It seems to be contended that such a number was necessary, or if not necessary at least desirable, as contributing in some way to the benefit of the colour-using industries. This may be doubted.

The Pre-war Position in Germany

It must be remembered that prior to 1914 the German dyestuffs industry consisted of nine firms of major importance and a few smaller firms, all engaged in vigorous competition with each other. There was, therefore, not the concentration of technique and manufacture in Germany which the German monograph appears to suggest. The output of the major firms averaged less than 15,000 tons, the individual output probably varying from 3,000 to 25,000 tons per annum. All the firms were prosperous and secured a remunerative return on their capital. There seems to be no reason, therefore, why a firm carrying on business on a similar scale in other countries of the world should not have been equally successful provided it had at its disposal the same degree of technical skill. It is true that the German firms had a common advantage in the close co-ordination existing between the universities and commercial undertakings. This advantage was not confined to the chemical industry, but was a marked feature of German industrial development, which other countries have since followed. It may be true that no country has yet reached the technique developed by the Germans over a long series of years, but the progress made in the big industrial countries which have undertaken the manufacture of dyestuffs has been remarkable, and much more rapid than anyone acquainted with the complications of the industry would have ventured to predict. This progress is being continued, and within a few years there seems to be no reason why these younger industries should not be able to develop and maintain themselves out of their own resources. Furthermore, commercial organic chemistry has, since the war, shown a tendency to increase its boundaries, and dyestuffs, pharmaceutical and photographic products, which constituted the production in 1914, are not now the only products which can be manufactured in a factory equipped for dyestuffs manufacture.

It should be noted that the vigorous competition between the German dyestuffs firms was the chief reason which led to the multiplication of types of dyestuffs sold. The number is placed in the German monograph at 1,500, but this number could be, and will in time undoubtedly be, considerably reduced with advantage both to the maker and to the consumer. It could be reduced probably by more than one half.

On these grounds, therefore, the British view-point differs a little from that of our German associates. Nor can the views expressed in the German monograph on the steps which have been taken to build up and maintain dyestuffs industries

in various countries be accepted in their entirety. It is admitted that to concentrate the industry in one country has certain advantages in fostering its development and very material advantages to the country itself. But the dyestuffs industry is in a very special position for two reasons: (1) On it is dependent the commercially infinitely greater textile industry, and (2) it provides a magnificent training ground for young chemists. It was, therefore, essential for Britain, in common with other countries, to provide herself with an industry which was of such importance to her national welfare. It is true, as stated in the German monograph, that "the market of each individual industry can, therefore, be only a fraction of the market which Germany monopolised before the war," and that "the consequence is that there is now in each of these industries a thoroughly unsound ratio between overhead costs and current costs of production (expenditure on raw materials, power and wages)." The monograph then continues: "Consequently, in none of the new producing countries have the younger industries been able to develop and maintain themselves out of their own resources. Not only has it been necessary in many countries to spend public money on their maintenance, but the whole market has had to be protected by high customs barriers, and in some cases import prohibitions have been required to regulate and restrict artificially the influx of foreign dyestuffs."

On this certain comments must be made. First, the various countries were compelled to establish these industries by the failure of the supplies of German dyes at the outbreak of war in 1914. Secondly, it is not an unusual thing for an industry to have to adjust itself to a lessened demand for its products; it is unpleasant, it takes time, but it is done. Thirdly, the production of dyestuffs is only a branch of chemical industry, and it can so be linked with other branches as to mitigate the financial hardship involved in reconstruction. Fourthly, it should be recognised that other countries cannot be expected to do in ten years what Germany has had fifty years to accomplish. Lastly, the reference which is made to the assistance which other countries have received by way of public money, high customs barriers, and import prohibitions is incomplete. In the development of her industry over the fifty years referred to above, Germany has not been entirely without the support and assistance of her Government.

Supply of Raw Materials

Agreement can be expressed with the German monograph on this aspect of the subject. In Britain, perhaps, more stress is laid on the importance of coal, not only as a source of power, but as a source of innumerable products obtainable according to the method of treatment employed. Other products—such as pyrites and sulphur—may, to some extent, be substituted, but coal and salt are the fundamental raw products of chemical industry, and of these Britain has ample supplies. The manufacture of aniline dyes, for example, depends mainly upon supplies of tar products, acids, bases, inorganic salts, bromine, heavy metals, sulphur, and alcohol.

At the present time developments are taking place in every direction, and the possible effect upon the dyestuffs industry of the commercial synthetic production of the industrially important alcohols, or of the investigations into the conditions of carbonisation of coal can hardly be estimated. The availability of cheap alcohol is bound, however, to be highly beneficial to those operations which involve its use as a solvent or as an alkylating agent, or which depend upon formaldehyde which, at the present time, is obtained commercially exclusively from methanol. A very general and widespread activity is abroad in the realm of fuel and coal gas, embracing work on the determination of the influence of temperature of carbonisation of coal on the composition of the resulting tar. This is a question which is of first importance to the manufacturer of intermediates and dyestuffs who is dependent upon coal tar for supplies of essential hydrocarbons, phenols, pyridine, etc. If, for example, as a result of the research which is being carried out, the composition of the tar were varied in the direction of a greater proportion of the simpler hydrocarbons at the expense of anthracene, the synthetic manufacture of anthraquinone from naphthalene by condensation of benzene with phthalic anhydride by way of benzoyl benzoic acid, would assume relative commercial importance. That is to say, a set of conditions would have been created, which, as in the United States of America at the present time, would render a synthetic

process for the manufacture of one of the basic products of the dye industry a possible commercial success.

Non-Economic Factors

Nor can any exception be taken to the statement of fact that of recent years there has been a tendency among the countries to develop chemical industries within their borders for the purpose of making themselves as economically independent as possible. Although it is nowhere so stated, this appears to be regretted by the writers of the German monograph. Reference is again made to the State assistance given in the form of tariffs, prohibitions and "even money subsidies." Preference is apparently given to the system whereby each country makes what it is best fitted to make and exchanges these goods for others made in the countries most naturally equipped for making them. The system is theoretically ideally perfect, but unfortunately is difficult to carry out in practice. If the dyestuffs industry, to which reference has been made previously, be taken as an example it will be observed that development did not follow these lines. It cannot be said that Britain was not as well equipped as any other country to develop the industry after the original discovery of Mauvein. Yet it was

most successfully developed in Germany. Further, sufficient attention is perhaps not paid to the fact that although the chemical industry is really a collection of industries they are indissolubly interlocked. It is impossible to divorce economically the distillation of coal from the distillation of tar, the preparation of the intermediate products, the production of dyestuffs and of fine chemicals. To only a lesser degree it is also necessary that these coal tar industries should be associated with the heavy chemical industries.

National independence is a strong factor to which great importance will continue to be attached on purely economic grounds, for the reason that very many trades are dependent in an ever increasing degree upon synthetic products. This need for independence in regard to dyestuffs and fine chemical production is all the greater because there have been in the past instances in which a country considered it could keep the method of production secret to compel other importing countries to pay exorbitant prices for the commodity. The production of fine chemicals has in the past lent itself well to secrecy, and secrecy has consequently been a strong factor in the situation.

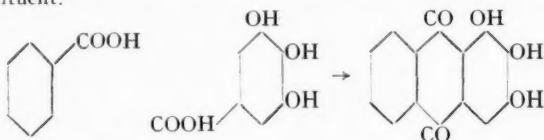
Dyes and Their Application: Recent Technical Progress

By L. J. Hooley

Phthalic Anhydride

ANTHRAQUINONE derivatives can be obtained either directly from anthracene by extraction from anthracene oil, purification and oxidation, or synthetically from substituted benzoic acids, of which the most important for this purpose is phthalic acid. The synthesis from these carboxylic acids is variously carried out with boric acid, sulphuric acid and anhydrous aluminium chloride. Except for a few compounds, the synthetic method has not generally been able to compete technically with the extraction and oxidation method. The most important exceptions have been (a) Anthracene Brown obtained from benzoic and gallic acids with sulphuric acid; (b) Quinizarine from phthalic anhydride and parachlorophenol with boric and sulphuric acids; and (c) 2-Methyl-anthraquinone from phthalic anhydride and toluene with aluminium chloride and sulphuric acid.

These three examples also very conveniently illustrate the three most important variations of the synthetical method. In the first, there is one carboxylic acid group in each constituent.



It is only applicable to a few derivatives, and is otherwise chiefly of theoretical interest.

The third example above takes place in two stages; aluminium chloride, toluene, and phthalic anhydride give toluoylbenzoic acid, and the toluoylbenzoic acid is then converted to 2-methylanthraquinone by sulphuric acid with loss of a molecule of water. This is the most important of the three, as it is the only one which is general, and which can be used for anthraquinone itself. The necessity for aluminium chloride is a big disadvantage, as this is comparatively expensive for use in the synthesis of a basic intermediate.

Quinizarine Derivatives

The second method—(b) above—is very similar to the first, and shares with it the advantage of cheapness and of giving the anthraquinone derivatives straight away. It provides a valuable way of manufacturing quinizarine, the source of some of the most important Acid Alizarine colours.

It has been recently extended by British and American investigators to derivatives of similar type, but its scope is very limited. In B.P. 234,533 (S. D. L., Thomas and Hooley) it was shown that instead of *p*-chlorophenol, the similar *o*-chlorophenol, or 2,4-dichlorophenol could be used, these giving 2,3-chlorhydroxy-anthraquinone and chlor quinizarine. The same chlor quinizarine has now been obtained from the isomeric 3,4-dichlorophenol by the same method (B.P. 260,544,

Newport Co.) The boric acid in these reactions operates both in the condensation and in the hydrolysis of the alpha-chlor atom. Dodd, Sprent, and United Alkali Co. describe in B.P. 245,584 the production of quinizarine from *o*-chlorophenol using boric acid, and of chlorhydroxy anthraquinones from both *o*- and *p*-chlorophenol without boric acid.

It is interesting to note that the production of quinizarine from *p*-chlorophenol helped to establish the position of the chlorine in this substance (*Ber.*, 1875, 8, 152).

According to F.P. 550,364, the production of Anthracene Brown is very much improved, if the benzoic and gallic acids are heated with sulphuric while air is excluded. The yield is stated to be doubled and the product obtained much purer.

The third method of synthesis, the modified Friedel-Craft reaction, has during the last few years attained considerable importance in America where the supplies of anthracene oil, as a result of the use of anthracite, are smaller. The most important stage in this was the development of the air-oxidation method for the production of phthalic anhydride from naphthalene, by Conover, Gibbs, and others in America and Wohl in Germany. The production of anthraquinone is a well-known process, the yields being almost theoretical, so that there have not been any important additions to the process as a result of its recent exploitation. As a matter of fact, the main lines of the synthesis of anthraquinone bodies in this way had already been laid down in Germany and Switzerland before the war, following on the importance assumed by phthalic anhydride as an intermediate in the synthesis of indigo. It is, however, unlikely that many of these were actually worked.

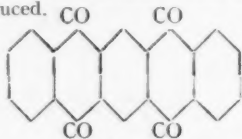
The production of 2-chlor-anthraquinone from chlorbenzene is already known. Only recently have dichlor-anthraquinones been produced from dichlorbenzenes. Max Phillips has condensed ortho- and para-dichlorobenzenes, producing from the former 2,3-dichlor-, and from the latter 1,4-dichlor-anthraquinone (*J.A.C.S.*, 1927, 49, 437 and 1926, 48, 3198). As normally, dichlor-benzoyl-benzoic acids are first formed, and these then treated with sulphuric acid. The 2,3-dichlor body appears to be formed exclusively, although generally the 3¹:4¹-substituted *o*-benzoyl-benzoic acids give both 1:2- and 2:3-anthraquinone derivatives on ring closure. Previous unsuccessful attempts at these syntheses have been reported in the literature.

Dinaphthanthracene-diquinone

In addition to phthalic acid, the 1:2:4:5-tetracarboxylic acid of benzene (pyromellitic acid) and the hexacarboxylic acid (mellitic acid) will condense with benzene in the form of their anhydrides. Several higher homologues of anthraquinone of the dinaphthanthracene-diquinone type have been prepared in this way.

In a series of recent papers in the *Monatshefte* (1927, 47, 519, 619), Seka and his collaborators describe the production

of derivatives of dinaphthanthracene-diquinone, including the reduction of this body and the production of nitro, amino and arylido derivatives. The reactions of this quinone are not exactly analogous to those of anthraquinone. Thus by heating a mono-nitro derivative with aniline, two anilido groups are introduced.



Although compounds of this type appear to offer considerable scope for the production of series of compounds, parallel to the already known and valuable anthraquinone ones, they are technically handicapped by their high initial cost.

Syntheses from Opianic Acid

Another method of synthesis, discovered by Bistrzycki and not so far mentioned, has been recently developed by Adams. Bistrzycki condensed ortho-aldehyde-acids with cresols and cresol ethers. Now, using a substituted aldehydic acid such as opianic, this on condensation with a phenol, gives only one derivative, whereas a substituted phthalic acid with its two carboxylic acid groups may give a mixture of two, or if only one is formed, its constitution is ambiguous. These substituted aldehydic acids are, therefore, very valuable for elucidating structure. Condensation takes place para to the hydroxy group, but by filling the para position with a bromine atom, Adams has been able to obtain condensation in the ortho-position. After condensation the bromine is removed, the benzylbenzoic acid converted to an anthrone, and then oxidised.

Dyestuffs Markets: The Month's Business in Review

From Our Own Correspondents

Lancashire

The dyestuff market showed very little change during the month of June, with perhaps a tendency towards a smaller demand. The position is undoubtedly better than it was a few months ago, but there can be no great change until the cotton industry shows an improvement. The opportunity to test the effect of cheap cotton on the Lancashire trade has not materialised, owing fundamentally to the clever marketing of the cotton crop. The Mississippi floods helped considerably, and it would appear that a few boll weevils later will be sufficient to keep the price of cotton up, despite the fact that the estimated surplus is some seven million bales. With the increased cotton prices the market is firmer. With more settled conditions, China is buying again, and the favourable monsoon news should stimulate Indian buying, with the result that on the whole the outlook is favourable.

A decided novelty in the market is the appearance of French dyestuffs, made by the Compagnie Nationale and offered by Brown and Forth. The range would appear to include several dyestuffs not made in Great Britain and hitherto imported from Germany. The effect of this competition on the prices of the German colours will be watched with interest.

Yorkshire

It is regretted that June cannot be reported to have brought with it an improvement in trade. On the other hand, it is, perhaps, a matter affording some consolation that, in spite of the Whitsun holiday and the fact that Yorkshire collieries are working only two or three days per week, dyestuff makers report a steadiness and a result similar to those of May.

The Huddersfield trade has somewhat slowed down, the conditions not being quite as good as they were a month ago. In the worsted section the effect of "between seasons" is being experienced. Last month we reported a continuance of demand for fancy weaves and rich colourings; it still predominates, but plain cloths in the finer qualities are now also being taken up. The woollen trade has developed briskness, and good business is being done with the Continent. Dewsbury notices that in the women's trade there has been a definite turning away from velours towards tweeds of a class helpful to the trade of the district. Canada and Holland continue to furnish the largest overseas orders, and trade is being done with Germany. Competition with the factories of Germany, Italy, and Czecho-Slovakia is, however, still severely felt both at home and in foreign markets. Japan has placed increased orders, but the cloth trade with China is slight and consists mainly of orders for scarlet blankets.

The continental deputation sent by the Colour Users' Association made investigations which revealed the fact that a certain British-made colour was being sold on the Continent at a lower price than that which British users in the home market had to pay, and the matter is being taken up by the Association's representatives on the Dyestuffs Advisory Licensing Committee. Surely it is an old practice, and one followed very extensively pre-war by the Germans, to the serious cost of the English colour industry. On the other hand, it is felt by the makers that they have a real grievance in that the Dyestuffs (Import) Regulation Act, established to

nurture their industry during its nursery days, should be rendered almost ineffective by the existence of a price factor and complete absence of evidence of pre-war values. Apparently there is no sealed pre-war sample available, and doubt is openly expressed as to the fact that certain standards of strength, put forward by the colour user are actually those to which the stated pre-war prices refer. At the same time, while inquiries show that prices charged by German manufacturers, for dyestuffs used in Germany are 60 to 70 per cent. above pre-war level, many of the British-made colours are being sold to British consumers at prices very much less than 60 per cent. above pre-war level. Indeed, in some instances, pre-war level has been reached.

Scotland

June has been a slightly disappointing month. While the textile trade, generally, has maintained its previous prosperous position, there is no indication of continued improvement; the dyeing and finishing trades have been slightly less busy and there has been some falling off in dyestuff orders. Perhaps, however, with the desire for improvement so strong, feeling is unduly sensitive to any indication of decline, and any set back to the general improvement which has been noticeable during the last month or two is regarded more seriously than it need be. Although it is really a little early to cast any blame on the holidays these may be exerting some influence. There is no doubt that, at the present time, most buying is from hand to mouth, and that the prospect of holidays in the near future will prevent the placing of further orders where stocks are sufficient to carry over this period. As, however, July is the most important holiday month in Scotland and is sure to show some dislocation, it looks as though it would be August, at the earliest, before any further improvement may be looked for.

Conditions at Hawick in the tweed and hosiery sections are, perhaps, a little less uniformly good than last month, and a few manufacturers have not got a great deal of work in sight. Work on the spring patterns is going forward rapidly, and the tendency is to attach still further importance to fancy goods. At Galashiels employment is good and a number of manufacturers are working overtime; and there is an improvement at Dumfries. In the Glasgow district, dyeing and printing are a little below the level of last month.

A further stage in the development of the Scottish Artificial Silks, Ltd., was marked by the recent issue of the remainder of the share capital. The balance sheet of J. and P. Coats, Ltd., shows a decline on last year. Part of the blame is laid to the charge of current dyestuff prices, although there should be even less excuse for this plea in this case than in others.

Mr. Sutcliffe Smith's review at the annual meeting of the Colour Users' Association provides its usual interesting reading, with its balanced, appreciative, and critical survey of the British dyestuff position at the present time. The value of the dyestuff imports for last year is, perhaps, a little disquieting. Whether it means anything else or not, it indicates practically a million pounds going abroad which would be better augmenting the resources of the industry here.

Dyestuffs Monthly Supplement

Published in the second issue of "The Chemical Age" each month

Communications relating to editorial matter for the Dyestuffs Monthly Supplement should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Advertisement matter, subscriptions, etc., should be sent to the Manager. The Supplement is devoted to the interests of both manufacturers and users of dyestuffs, and contributions will be welcomed.

Dyestuff "Arrangements"

OUR well informed Lancashire correspondent, in his market report for July, makes some interesting comments on rumours as to contemplated changes in dyestuff organisation which have been attracting attention recently. It is reported, for example, that an arrangement has been arrived at whereby the British Dyestuffs Corporation is to manufacture certain of the calico printing specialties of Durand and Huguenin S.A. of Basle, and that the firm of Bard and Wishart of Manchester will continue as the sole selling agents for such specialties in Great Britain. Another less definite but widely spread rumour relates to certain "business arrangements in the dyestuff world." There is no indication of what these "arrangements" are, but one may assume that, following the modern fashion, they have to do with the restriction of wasteful competition, the adaptation of output to the available markets, and the better organisation of sales and distribution in reference to the needs and convenience of consumers. Opinion in the industry appears to be quite ripe for some scheme for rationalising and co-ordinating its activities.

Caledon Colours on Cotton Yarns

WE have received from Scottish Dyes, Ltd., Grangemouth, a folding pattern card of more than usual interest, showing their Caledon Colours on cotton yarn. The shades shown, beginning with yellow and ending with black, number a level 12 dozen, and include straight colours and compound shades. If this stood alone, it would be a remarkable testimony to the advance this country has made in the production of vat colours since the war, when such colours were almost, if not quite, outside the range of British production. The Caledon Colours belong to the anthraquinone vat series and are of unsurpassed fastness, and their use is regarded as essential for the highest classes of fast coloured goods. The present pattern card shows the colours in self and mixed shades on a mercerised bleached cotton yarn. Except where otherwise stated, the dyeings are of simple strength pastes. The Caledon Colours can also be obtained as double strength pastes and triple strength powders. When dyeing self shades they fall into three groups, and the dyeing method appropriate to each group, as well as the fastness qualities, is given in tables. For dyeing mixed shades it is generally advisable to mix colours that occur in the same group, and not to use hot and cold dyeing colours together, though there are exceptions to this rule. Suitable mixtures for a large range of shades may be obtained from the present patterns. Dyeing may be carried out in wooden or in iron vats, but a warning is uttered that no other metal should be used, unless it be Monel metal. The methods differ according to whether the goods are to be dyed in the beck or in machines.

A New Geigy Red

To their well-known range of Polar Colours the firm of J. R. Geigy, of Basle, have now added No. 717 Polar Brilliant Red B conc., which is shown on a pattern card received from the Geigy Colour Co., Ltd., of Manchester, dyed on wool, weighted and unweighted silk, and wool and silk. Four shades of the colour are illustrated, as the result of 0.5 per cent., 1 per cent., 2 per cent., and 3 per cent. baths, and the effects, whether on silk or wool or a mixture

of both, are equally satisfactory. The outstanding feature of the new colour is its brilliance and purity of shade, in which it excels all the other colours of the series. It is recommended, like the other Polar Colours, wherever good fastness to light and to washing and ordinary fastness to milling are required. In consequence of its fastness to sulphur stoving, it is especially suitable to the manufacture of blankets, and its fastness to acid milling makes it of interest in hat manufacturing.

New B.D.C. Colours

THREE new colours are announced by the British Dyestuffs Corporation—Naphthalene Fast Black 4B, an addition to their range of acid colours; Thionol Brown G, an addition to their sulphur colours; and Chestnut Brown, an addition to their acid colours for leather dyeing. Naphthalene Fast Black 4B is particularly applicable to the dyeing of wool hosiery yarns and material for knitting purposes generally, since it gives what is described as "a full bloomy tone, with good fastness to washing." It is also of particular interest for the dyeing of hat bodies, as it possesses good penetrating properties and fastness to water. In the latter respect it is said to be superior to the average acid black, and in addition it is not affected by dyeing in copper vessels. The garment dyer will note that it dyes wool and silk fairly well from a neutral dye bath.

Thionol Brown G, which gives a bright yellowish brown shade, is applicable to all types of cotton materials where fastness to washing is of primary importance, while the very good fastness to cross dyeing makes the colour particularly applicable for dyeing cotton warps, such as are used for the production of mohair linings and union gabardines. It is also recommended for the dyeing of cotton materials that are subsequently to be rubber proofed, as it is fast to the "cold cure" vulcanising process.

Chestnut Brown is intended for the use of dressers of chrome, semi-chrome, and vegetable tanned leathers. It is described as possessing good solubility and excellent level dyeing properties. In addition to its value as a self colour, it serves as an excellent basis for the rich brown shades so much in demand for shoe and fancy leathers. For this purpose it can be shaded with Citronine R conc. or Acid Phosphine R and Naphthalene Black 12B. In the dyeing process, it is stated that in the case of chrome leathers, while previous mordanting with tanning extracts may be adopted, equally good results can be obtained without using this process.

Dyestuff Prices and Textile Trade

IT seems clear from recent references that the impression in some quarters, that the selling prices of textiles are seriously affected by the prices of the dyestuffs used in their colouring, has been effectually removed. Mr. Sutcliffe Smith, in his address to the Colour Users' Association, made a fairly pointed reference to "distorted references to the effect of dyeware prices on the textile industry." "It has been alleged," he said, "that the Dyestuffs (Import) Regulation Act has been the cause of the setback in sections of the textile industry. Whilst it is imperative that every cost in the items of production must be brought

down to the lowest economic price, I suggest that in many instances exaggerated statements have been made as to the cost of dyewares reflected in the ultimate selling price per yard of cloth. On the other hand, I contend that the fostering of the dyemaking industry in this country has been of considerable assistance to the textile trade, as, for example, in the production of dyes for the new fabrics which have been developed so rapidly during the past few years." The Clayton Aniline Co. supplies testimony to the same effect, declaring that they have on numerous occasions investigated cases of alleged loss of trade due to the high cost of dyestuffs, and in every instance have been able to prove that the actual cost of the dyeware on the finished fabric is so small as to be a comparatively negligible factor, and that the true explanation is that labour costs and conditions on the Continent are so much more favourable than at present prevail in this country that even if the cost of dyestuffs were omitted entirely, the result would be the same. They even suggest a Board of Trade inquiry, being confident that the result would be a tribute to the valuable work for the nation done by the British dyemaker.

Dyestuff Licences for July

THE following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during July, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee:—

The total number of applications received during the month was 641, of which 480 were from merchants or importers. To these should be added 26 cases outstanding on June 30, making a total for the month of 667. These were dealt with as follows: Granted, 578 (of which 532 were dealt with within 7 days of receipt); referred to British makers of similar products, 70 (of which 51 were dealt with within 7 days of receipt); referred to reparation supplies available, 3 (all dealt with within 2 days of receipt); outstanding on July 30, 1927, 16. Of the total of 667 applications received, 586, or 88 per cent., were dealt with within 7 days of receipt.

German Dyestuffs Exports

THE statistics for the first quarter of 1927 show that, evidently without detriment to the domestic market, exports from Germany of the more important synthetic dyestuffs have increased. Aniline, tar, and sulphur dyestuffs exports were 6,963 metric tons, as compared with 4,957 in the same period of 1926. The relative increase in alizarine dyestuffs was even greater, having been 1,235 tons, as compared with 272 tons. Indigo was exported to the amount of 4,517 tons, as compared with 3,942 in the first quarter of 1926. Heavy competition in indigo by three American companies has been mentioned in Frankfurt lately, principally with regard to the Japanese and Chinese markets. Apparently not only the Germans but also the Swiss are affected by this competition.

Spirit Soluble Colours

THE latest American products include a new range of spirit soluble colours, which the Du Pont Co. are marketing under the name of Luxol Colours. The special features of this series are their solubility, exceptionally good fastness to light, and the wide range available. The Luxol colours are soluble not only in methyl and ethyl alcohol, but also in pyridine, furfural, and diacetone alcohol; a few are even soluble in acetone. With those soluble in ethyl and methyl alcohol the wood finisher is able to stain wood previous to the application of pyroxylin lacquer without any danger of the colour bleeding into the lacquer; at the same time the use of these colours avoids the raising of the grain and obtains a fastness equal to that of the acid water stains. The solubility of some of them in the higher alcohols makes possible a wide range for producing transparent coloured pyroxylin lacquers of exceptional fastness to light. The same company also announce a

new diazo colour and an olive drab sulphur dye, to be known respectively as Pontamine Diazo Orange G and Sulfogene Olive Drab Y.

American Shades for Autumn

THE hosiery colours issued for the United States autumn season, 1927, by the Textile Colour Card Association in co-operation with the National Association of Hosiery and Underwear Manufacturers comprise delicate shades for evening and darker tones for daytime wear. The new evening tints are Opera Pink, a rose which harmonises with Debutante Pink, Opal Mauve, a pale violet, and Vanity, a nude shade. Other colours include Mirage, a greyish beige; Yosemite, a golden lustre appropriate for autumn, and Bronze Nude, a medium brown; Seasan, a light greyish tan; Manon, a medium brownish grey; Merida, a soft café-au-lait colour; Beechnut, a shade darker, and Rifle, a dull slate grey. Some colours repeated from former cards because of their popularity are Harvest, Moonlight, French Nude, Grain, Dove Grey, Evenglow, Blue Fox, Aloma, and Beige. Incorporated in the hosiery card are also the shoe colours. The six shoe colours chosen by the allied shoe and leather committee appointed by the Tanners' Council, the National Boot and Shoe Manufacturers' Association, and the National Shoe Retailers' Association, in co-operation with the Textile Colour Card Association, are Brierwood, a mahogany, Andorra, a deep-toned brown, and Whippet, a neutral shade bordering on fawn. The well-known Stroller Tan, a rust shade, Sauterne, a light gold-tinted tan, and Plaza Grey, a medium tone, have been retained.

Dyestuffs Research in America

TECHNICAL research on dyeing and textile chemistry has been distinctly advanced by the intensive studies undertaken by the American Association of Textile Chemists and Colourists. The Research Committee of the Association has laid the groundwork for some years of future research on the fastness of dyes and related problems. So fruitful have been its preliminary efforts that the Association has now appointed a regular Research Associate to assist in carrying on further studies at the Bureau of Standards in Washington. With the establishment of more intimate contact with the Bureau of Standards laboratories, the work of the Research Committee enters upon a new and promising stage. The committee's principal project, a series of exhaustive tests for the purpose of standardising the fastness of dyes, has been generously aided during the past few years by one of the Bureau's chemists, and during last summer the Association had a second research assistant engaged at the Bureau laboratories. This assistance, though capably rendered and of the utmost value in advancing the project, lacked the continuity so essential in scientific studies of any kind. A Bureau chemist can devote only a limited time to co-operating with the various research associates established at the Government laboratories by trade and technical groups. The new associate, on the other hand, has been engaged under yearly contract to give his entire time to the Association's research work on dye application and textile chemistry, and will consequently be able to develop more rapidly the special phases of this work assigned to him by the Research Committee. His operations will be supervised by the Committee, to which he will regularly report, so that the progress of his studies will be definitely marked. He will probably be engaged at first in completing the work of standardising the fastness tests and classifying dyestuffs according to these tests. One of the important projects planned by the Association is the establishment of a service for distributing dyed samples based on these fastness standards. In this standardisation work it will co-operate with the British Society of Dyers and Colourists.

Treating Silk with Tannins

(From a Correspondent)

THE application of tannin to silk has some importance in various branches of the industry, either as a mordant, directly for weighting, or as the preliminary for a fast deep black. For the first purpose, when a tannin-tartar mordant is employed for basic dyes, a fairly pure tannic acid is used in order that the silk may be kept as nearly white as possible. If this is not done there will be a loss of brightness in the resultant shade.

A typical formula for this would be :—

Tannic acid	10 lb. to 40 lb.
Soft Water	100 gals.

The amount of tannic acid varies according to the depth of shade to which the silk is to be dyed. The fabric is padded through the liquor at 140° F. six times, to and fro, whizzed and left damp for from four to eight hours. It is then passed, without washing, through the tartar bath :—

Tartar Emetic	5 lb. to 20 lb.
Soda Ash	$\frac{1}{2}$ lb. to $1\frac{1}{2}$ lb.
Soft Water	100 gals.

This bath should be used warm only, say, at 110° F. Unless the goods are of very light texture, they should be entered in the flat state, so that there may be no tannin unacted upon. They should be worked as much as in the tannin bath, and then rinsed very thoroughly. Generally this is followed by a soap wash, then another water rinse, after which the goods are dried if dyeing does not come immediately after.

Tannin for Weighting and Producing Black

When tannin is applied to silk for the purpose of weighting and for the production of black by means of iron, the two purposes are usually combined; that is to say, the manufacturer in getting his black desires that the silk shall be weighted at the same time. Tin-weighted silk can be dyed black in the ordinary way, but there are some special cases in which a tannin-iron or tannin-logwood-iron black is needed. In order to discover which of the large number of natural tans would give the best commercial black a great many experiments were made. Yellow Italian silk was used; it was prepared by soupling in a bath containing :

Green Olive Oil Soap	1 lb.
Soft Water	100 gals.

for half an hour at 140° F., and whizzing but not washing. The tan solutions were made up to a strength of 2° Tw. at 140° F. The silk was worked in this for half an hour and washed in cold, unsoftened water for ten minutes. It was then dipped in a bath of black iron liquor of 2° Tw. at 140° F. for half an hour and washed in soft water for ten minutes. It was then dried for a comparison of shade.

The following list of tans has appended to each a few words of description of the black obtained. The colour desired was a rich full black that was black; if it had a tinge of blue in it, it would perhaps pass, but a greenish shade or a tendency to rustiness were out of the question.

NAME OF TAN.	CONDITION.	COLOUR.
Borneo Cutch	Solid	Tinge of yellow
Burmah Cutch	Solid	Poor black
Chestnut (best French)	Extract	Tinge of blue
Crown Quebracho	Extract	Good black
Divi divi	Solid	Good black
Divi divi	Extract	Good black
Fustic	Extract	Brown
Gall	Extract	Good black
Gall (75 per cent. Gallotannic Acid)	Solid	Purple
Gambier (40 per cent. Catechol)	Solid	Green
Hæmatin	Crystals	Good black
Kino Gum	Solid	Grey
Locust Beans	Pods and seeds	No colour
Myrabolans	Ground	Good black, harsh
Oakwood	Extract	Good black, harsh
Persian Berry	Extract	Yellow brown
Plantation Gambier	Solid	Grey

Quebracho	Solid	Tinge of yellow
Quebracho	Extract	Tinge of blue
Quercitron	Extract	Tinge of yellow
Ratania	Root	Brown
Sumach	Ground	Good black, harsh
Sumach	Extract	Good black, harsh
Synthetic Tan	Liquid	No colour
Tannic Acid	Commercial	Tinge of purple
Tara (30 per cent. Pyrogallic Acid)	Pods	Good black
Tara	Ground	Tinge of purple
Valonia (30 per cent. Pyrogallic Acid)	Extract	Good black
Velonitan	Extract	Good black

The best of these were picked out for further consideration and testing. Several really good ones could not be used on account of their cost; others were dropped because additional plant would have been needed for their extraction, as they were only marketed in their natural forms; this was considered too expensive and troublesome. There are tans which yield a beautiful black but leave the silk harsh, and it is not always convenient to add softening agents which might interfere with subsequent processes. Finally the choice was restricted to two, namely, chestnut (best French extract) and divi-divi extract. They both give good full blacks, are comparatively cheap, easily obtained and ready for use. Chestnut alone had a slight tendency towards harshness, divi-divi alone was inclined to be a shade rusty, but a mixture of one part of chestnut with two or three of divi left little to be desired. There was a slight improvement in colour when a little sumach extract was put in, but again the harshness became prominent, and therefore it had to be dropped.

In order to arrive at these decisions a large number of trials were made, the final results of which are embodied in the accompanying table. Two kinds of silk cloth were used: A is Italian yellow only; B is Italian yellow warp with a white Japan weft. For the purposes of these tests the silk was not soupled, but was weighed after drying. The tests were made at four different temperatures on tan baths of 2° Tw. tested at 140° F. :—

TAN.	TEMPERATURES, ° F.							
	120		140		160		180	
	A	B	A	B	A	B	A	B
Divi-divi	30.5	29.5	32	31	34	32.5	34	36
Chestnut	26.5	24	29	25	31	30	36	40
Divi 1 part	28	26	30	28	32.5	32	35.5	39.5
Chestnut 1 part								
Divi 2 parts	29	26.5	31	30	33	32.5	35	38.5
Chestnut 1 part								
Divi 3 parts	29.5	26.5	32	32.5	33.5	32.5	34.5	37.5
Chestnut 1 part								

The above figures indicate the percentage of weighting added to the silk by simply dipping in the tan at the required temperature for half an hour and then rinsing in hard water for ten minutes, after which it was squeezed and dried for weighing. It will be seen that as the temperature rises, so the quantity of tannin absorbed by the silk increases, and also that Japan silk absorbs less than does the Italian at the lower temperatures, but at 180° F. the positions are reversed. The reason for this is that the Japan silk is a harder variety, one in which the sericin is less easily attacked than is the case with the Italian, but when it is heated sufficiently to soften the sericin, the tan absorption takes place readily enough. This change in the behaviour of different sorts of silk is a point that needs careful study at all times. China filature silk is, perhaps, the hardest of all those usually met with, and will allow of the highest temperatures without trouble, while Kashmir must be very carefully watched at anything over 140° F.

The variation in final results that arises solely from the differences in the silks themselves is a matter not sufficiently realised; the dyer may be, and frequently is, blamed for defects which are not the outcome of his carelessness, but which occur because he has received no warning as to the material he is using.

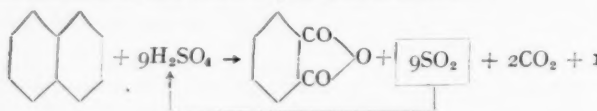
Basic Intermediates for Dyestuffs: No. X.—Phthalic Acid and Its Derivatives

By "Consultant"

To remark upon the large part played by phthalic anhydride and its derivatives in the dyestuffs industry is almost superfluous, since it has been recognised as a fundamental intermediate for the large scale manufacture of dyes since the synthesis of indigo was first put upon a commercial basis—an event which had its origin, almost fifty years ago, in the experiments of Baeyer. The various reactions which make phthalic anhydride such a desirable starting-point in dyestuff synthesis may be broadly divided into two groups: those in which one of the carbonyl groups undergoes a true condensation with the hydrogen atoms of another intermediate, as in the preparation of phenolphthalein, and the more important reactions in which it serves as the starting-point for amino-compounds containing a carboxyl group in the ortho position, i.e., the anthranilic acid series of compounds.

The extremely large quantities of phthalic anhydride which are required, mainly for the production of synthetic indigo, render necessary a cheap starting material; naphthalene, which sells at between 1½d.–1½d. per lb., furnishes this primary necessity. The processes by which naphthalene can be converted into phthalic acid invariably involve oxidation, much of which is done by sulphur trioxide, although an increasing quantity is now being oxidised by aerial oxygen through the intervention of a suitable catalyst.

The oleum-mercuric sulphate process depends for its success on a reaction which may be illustrated thus:—



and which takes place to a considerable extent only in the presence of a suitable catalyst, mercuric sulphate being the one most favoured industrially, although many others have been suggested and demonstrated to be effective. The preliminary operation in the older process is the preparation of a convenient solution of naphthalene. This is accomplished by the aid of sulphuric acid. Naphthalene (3½ cwt.) is added with stirring to sulphuric acid (66° Baume) (1 ton 17 cwt.) and 23 per cent. oleum (½ ton) is run in over a period of three hours. This solution of naphthalene is prepared in considerable quantity and is stored in tanks on the floor above the oxidising pans.

The oxidising pans are shallow pans of wrought iron—stainless steel is said to be not altogether satisfactory—seven to eight feet in diameter and about 2 ft. deep. The general appearance of the layout is shown in Fig. 1, which is, of course, diagrammatic. The stirrer provided for the oxidation pan has only the smallest clearance between its blades and the bottom, so that charring is minimised to a great extent, an effect which is sometimes aided by the addition of a number of steel balls to the charge. The cover is provided with the usual inlets for pressure gauge and thermometer, and a wide duct for the efficient removal of the vapours evolved. This latter is usually from 8 in. to 1 ft. wide, since a charge of over 100 lb. weight is worked off in a little over a quarter of an hour. To achieve sufficient control over the progress of the reaction the retort must be gas-fired. In working off the charges the catalyst is first prepared *in situ*. Sulphuric acid (2 cwt.), which has been adjusted with oleum to 100 per cent. strength, and mercury (10 lb.) are placed in the pan, and heated until the bulk of the excess of acid has distilled over. This takes about 1½ hours, after which a charge of the prepared naphthalene solution is run in—about 75 to 100 lb., according to the dimensions of the pan. The heating is then regulated so that the whole lot distils over in 15 to 20 minutes, after which a fresh charge of the prepared naphthalene solution is run on to the catalyst and the operation repeated. This repetition is continued until so much charring has taken place that the efficiency of the catalyst becomes affected. The efficacy of the catalyst can then be restored by the distillation from the

pan of a charge of plain sulphuric acid. After a time, however, even this fails to restore activity and the pan is opened up, chipped out, and thoroughly cleaned. The residues are worked up for the mercury which they contain.

The percentage of carbon dioxide in the exit gases, as measured by gas analysis, gives the control chemist an indication of the efficiency with which the catalyst is performing. When the carbon dioxide content reaches 0.8 per cent. it is a sign that cleaning by acid distillation is necessary, whilst when the percentage reaches 1.0 per cent., as it does fairly rapidly after a number of distillations have been run, complete overhaul is necessary. The vapours from the pans contain phthalic anhydride, sulphuric acid, and sulphur dioxide, together with carbon dioxide and traces of other compounds of no importance. They are passed into a special condenser fitted with concentric cylindrical baffles of lead, in which the sulphuric acid and phthalic anhydride condense and are removed as a sludge, whilst the sulphur dioxide is exhausted by fan and blown to the sulphuric acid plant to be reconverted into oleum by the contact process. It will be seen that the oleum plant and the phthalic anhydride plant are interdependent. The anhydride and acid in the sludge are separated by centrifuging, and the washed anhydride purified by sublimation from a shallow pan very similar to that used for the oxidation. The vapour of the anhydride condenses in large cylinders.

Other methods which have been patented from time to time include the use of the rare earths in place of mercury as the catalyst, a substitution which enables the oxidation to take place at a lower temperature, thus decreasing the decomposition and charring. Another process, of no immediate importance, involves the oxidation of naphthols, dissolved in a very slight excess of alkali, with gaseous oxygen in the presence of metal oxides, such as those of copper, barium, manganese, and lead. Benzoic acid is produced at the same time. Much more important is the process of aerial oxidation of naphthalene in the presence of a suitable catalyst. Briefly, the process involves the passage of a mixture of naphthalene vapour and air over heated vanadium pentoxide (or less effectively, molybdenum oxide). Details of the few plants which have been erected for the preparation of phthalic anhydride by this process are difficult to obtain, but in one such the *modus operandi* is as follows: The first consideration is the production of a definite concentration of naphthalene in the air which is passed over the catalyst mass. Air is blown through a series of coils, heated by producer gas, into the bottom of a small iron chamber several feet in height. This

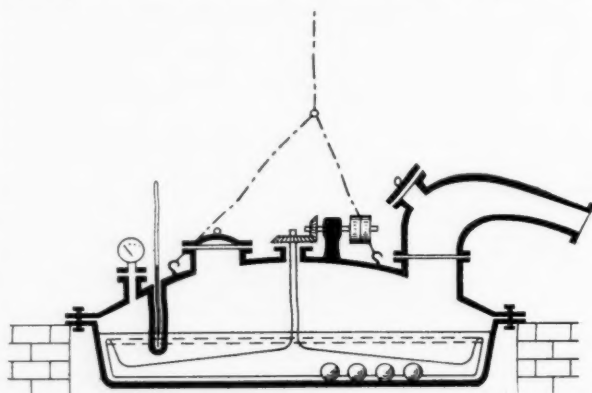


FIG. 1.

is mounted in a brickwork chamber and uniformly heated to 250° C. whilst into the top of the cylinder molten naphthalene

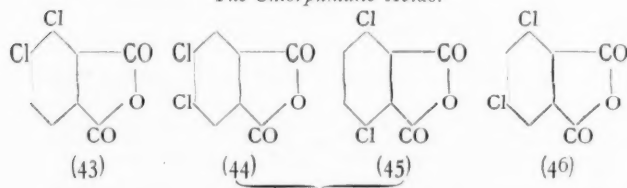
is forced under pressure through an atomiser, the supply to the latter being controlled by a large surface needle valve, through the centre of which passes a current of hot oil. By adjusting the needle valve and the speed of the blower a gas with a predetermined concentration of naphthalene vapour can be blown into the catalyst tubes. The duct between the "carburettor" and the catalyst tubes is jacketed with oil at 230° to 250° C., to prevent condensation and choking.

The catalyst mass is made from certain anhydrous salts (such as magnesium sulphate) impregnated with vanadium pentoxide and so shaped as almost to fill the tubes, which are initially heated electrically to a temperature of 450° C. Oxidation proceeds smoothly at this temperature, the evolution of heat being balanced by radiation, and there being no risk of explosion, as when oxygen is used to replace air. Not all the naphthalene is oxidised in this manner, from 25 per cent. to 35 per cent. being recovered unchanged. Of the remainder 60 to 80 per cent. is recovered as phthalic anhydride, a figure which compares very favourably with the comparatively poor yield obtained by the sulphuric acid process. The most objectionable feature of the aerial oxidation process is the difficulty of dealing with the vapours after they leave the catalyst tubes, since any simple form of condenser is almost immediately choked by the rapidly deposited naphthalene and phthalic anhydride. Several processes have been suggested for the condensation and separation of these two substances, but so far the most effective appears to be the use of a mechanically raked flat surface condenser, combined with a spray scrubber using carbon tetrachloride. The carbon tetrachloride, which is part of a regenerative cycle, is mixed as it leaves the scrubbers with the solid product to give a boiling saturated solution, which is passed through decolourising charcoal, and cooled. The anhydride separates out leaving naphthalene which is extremely soluble in the tetrachloride. The naphthalene-carbon tetrachloride solution can be sprayed directly into the carburettor without entailing any great loss of the solvent, which is recovered in the condenser.

Phthalimide

Of the more important derivative of phthalic anhydride, phthalimide and the chlorophthalic anhydrides are those which have been selected for description. Phthalimide is manufactured by a comparatively simple operation, the action of ammonia upon phthalic anhydride. This may be accomplished either by the passage of ammonia gas through molten phthalic anhydride, or by the action of heat upon a mixture of ammonium carbonate and phthalic anhydride. In the latter process the procedure is simple, and more easily controlled than in the former. The anhydride is mixed with rather more than its weight of ammonium carbonate, and heated in shallow pans, with a cover and duct for the vapours evolved. Carbon dioxide, water vapour and a quantity of phthalic anhydride are evolved, while the phthalimide remains behind in the molten condition and can be run off, cast into slabs, and ground. When gaseous ammonia is used a more rigid control of the temperature is necessary. Phthalic anhydride (6 cwt.) is melted and ammonia gas passed, the temperature being held at 140° C. for the first four hours, after which it is raised to 170° C. for a period of eight hours, and finally held at 240° C. for six hours. The molten phthalimide which remains can be dealt with as in the carbonate process.

The Chlorophthalic Acids.



vicinal	symmetrical		asymmetrical
3:4	4:5	3:6	3:5
m.p. 122° C.	m.p. 186° C.	m.p. 192° C.	m.p. 89° C.
b.p. 330° C.	b.p. 313° C.	b.p. 340° C.	b.p. —

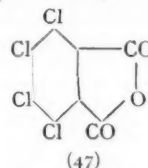
Of the four possible isomeric dichlorophthalic acids, all are known, but only the 3:4, 4:5, and 3:6 derivatives can be produced on a commercial scale. The 3:5 derivative can only be produced with difficulty, and in small quantities, by the action of phosphorus pentachloride on dimethyldihydroresorcin.

The other three isomers are produced by the chlorination of a sulphuric acid solution of phthalic anhydride. The anhydride (60 lb.) is dissolved, together with iodine ($\frac{1}{2}$ lb.) in 23 per cent. oleum (3 cwt.) and a slow stream of chlorine passed in. The temperature is gradually raised from 40° to 60° C. and the passage of the gas continued until the increase of weight is $\frac{1}{2}$ cwt. At this point the passage of the gas is stopped and the chlorosulphonic acid which has been formed is distilled off up to 250° C., and the residue cooled. The solid residue is shovelled on to ice, and the mixture of chlorophthalic anhydrides filtered off and washed with a limited amount of cold water. For purposes of dyestuffs manufacture no separation of the mixture is made, and the product is dried straightway. It consists of —

- 3:4-Dichlorophthalic anhydride, 30 to 35 per cent.
- 4:5-Dichlorophthalic anhydride, 15 to 20 per cent.
- 3:6-Dichlorophthalic anhydride, 50 per cent.

When specially desired the separation can be effected by the varying solubilities of the zinc salts.

The di- and tetra-chlorophthalic anhydrides are used for the preparation of condensation products through the carbonyl group, yielding dyes of the Rose Bengal and Phloxine series, which are much brighter and of a more bluish tone than those from phthalic anhydride itself. The tetrachlor-derivative (47) is also prepared by the chlorination of phthalic anhydride



in oleum solution. The anhydride (60 lb.) is dissolved, together with iodine (3 lb.) in 50 to 60 per cent. oleum ($1\frac{1}{2}$ cwt.) and chlorine passed in at a temperature of 50° to 60° C., the temperature being gradually raised to 200° C. At the end of the reaction the chlorosulphonic acid is distilled off and the cooled residue treated with ice. The tetrachlor-derivative can then be filtered off, pressed, and dried.

Inquest on Process Worker

An open verdict was returned by the jury at Manchester on August 3, at an inquest on John Bunn, a process worker in charge of the oleum plant of the Clayton Aniline Co., Ltd., who was alleged to have complained that fumes were affecting his chest. Bunn, it was stated in evidence, had been in charge of the oleum plant a number of years, and, according to his wife, previous to his leaving his work on May 9, had complained of the fumes. A doctor diagnosed his complaint as bronchitis, and he was removed to hospital. A foreman stated that Bunn had been in the works for 25 years, and had not complained of fumes. Mr. D. M. Paul, departmental manager, explained in detail the working of the oleum plant, which was, he said, essentially a still connected with a condensing tower, the whole of the apparatus being cloaked and connected with tubes to the main works chimney or the outer air. According to medical evidence, death was due to heart failure brought on by bronchial pneumonia. The coroner told the jury that they could not ignore the fact that Bunn had complained to his wife his fears that the fumes were affecting his health. As stated above, an open verdict was returned.

German Potash Syndicate and Nitrogen Compounds

CONDITIONS in the German Potash Syndicate, which has hitherto sold nitrogen chiefly produced by the I.G., are likely to undergo a change in the autumn, for it seems probable that the Syndicate will handle the output of the big plants for the production of nitrogen compounds from coke furnace gases of the Mont Cenis and Hibernia Collieries, which are to commence working with a production of 9,000 tons each per month. In the year 1925-26 the sales of the Syndicate totalled 325,000 tons of pure nitrogen, and for the current year they are estimated at 390,000 tons.

A Continental View of the Dyestuffs Position

Temporary Pause in Discovery

The following article possesses the special interest of showing how the present state of affairs in dyestuff synthesis is regarded on the Continent. It was written by a Swiss dyestuff chemist, Dr. H. E. Fierz (of the Eidgenössische Technische Hochschule, Zurich), and appears in "The Manchester Guardian Commercial."

THE manufacture of aniline dyestuffs, before the war almost a monopoly of Germany and Switzerland, has undergone a very marked change in the last ten years. There have sprung up in England, France, Italy, and the U.S.A. new and powerful dyeworks, which are producing virtually all the artificial dyes formerly imported from Germany and Switzerland. Much and useful work has been devoted to this subject in the formerly Allied States, and this work can now be considered as completed. I do not, therefore, want to dwell on the achievement of days past, however remarkable, but I want to show what has been done in the time since November, 1918, up to the present.

It seems quite natural that the energies of English, French, Italian, and American chemists have been more or less absorbed by finding out the constitution of the old German and Swiss dyes, and that, therefore, the new products have been found and developed in the old and well-organised laboratories of the German I.-G. and the Basle firms, i.e., Society of Chemical Industry in Basle, Sandoz, and J. R. Geigy, Ltd. In reviewing the chemical production since the war, one has to distinguish between the perfecting of older products and the discovery of quite new types of chemical. The old times, when every year was marked by some discovery of great consequence, have decidedly gone, and it seems very unlikely that in the years to come there should be another period of revolution, or any change comparable to that from 1890 to 1914. Many of the well-known dyes are of so satisfactory a quality that there is no immediate need for a change, which could introduce only small improvements. And yet there can be no doubt that the comparative standstill at which we have arrived is only temporary, and is in part caused by the vexations of many countries which try to protect an industry which, in my opinion, would only flourish if it were not protected at all.

In no other industry does the price of really first-class product matter so little under the condition that the new and more expensive products actually show distinct properties unknown hitherto. This statement can be supported by the steadily increasing value of German and Swiss exports to the very countries which do not allow the import of the old dyes, and by the precarious situation of the new works, which are underselling each other to such an extent as to sacrifice almost all profit.

Perfecting Old Dyes and Intermediates

Before trying to explain to the reader some of the new products which seem interesting, I should like to show in what manner the old dyes and intermediates can be perfected. Benzene, naphthalene, and anthracene are among the most important raw materials of artificial dyestuffs, and the question arises how to transform them into a variety of complicated derivatives such as aniline, phenol, salicylic acid, α - and β -naphthol, phthalic anhydride, and anthraquinone. Great efforts have been made to perfect the manufacture of some of the intermediates, because very large quantities are required not only for dyes, but also in an increasing amount for other industries. Phenol is used much more in the pharmaceutical field and the manufacture of synthetic resins such as bakelite, whilst aniline derivatives are used as accelerators for rubber and tetrahydronaphthalene as lubricating oil, as well as a solvent for varnishes, lakes, and oils. In the preparation of these and similar products the catalytic oxidation of naphthalene and anthracene are the most important, not only because phthalic anhydride is an interesting product, but especially because it shows how quickly methods and principles shift in the domain of artificial dyestuffs. It must be explained that it is possible to manufacture anthraquinone either from anthracene or from phthalic anhydride, the actual yield being in both cases about 85 per cent. to 90 per cent. of the theory.

It was, in the judgment of many chemists, decided that anthraquinone would be produced in the end from naphthalene

by oxidising the same with phthalic anhydride according to the discovery of Wohl and Gibbs. But recently the Badische Anilin und Sodafabrik, Ludwigshafen, has started the catalytic oxidation of anthracene by the process of Wohl, and this new method seems to open the whole question again. The manufacture of aniline is a similar example of the shifting of methods, and it seems quite possible that in a few years to come nitrobenzene will be reduced by producer-gas and a catalyst like nickel or iron, doing away with the old method of iron reduction. The manufacture of phenol has been perfected by the Bakelite Co., which sulphonates benzene in the vapour phase.

Innovations in Dyeing and Finishing Methods

There are several marked steps in the methods of dyeing and finishing, all trying to simplify and to perfect the old methods. One part of these methods is physico-chemical, the other purely chemical. It is a well-known fact that many dyes have the disagreeable property of being moistened only with difficulty. This fact is the more unpleasant because sometimes the dyes produce much irritating dust which is intensely coloured, and on the other hand, dyeings get uneven and take much more time. The new products, of which Nekal, of the I.-G. (B.A.S.F.), is the most prominent, are now mixed with the dyestuff powder, which receives thereby the property of being easily moistened. In fact, the dyestuff powder, in many cases, behaves like sand, sinking and being thoroughly moistened and quickly reduced in the case of vat-dye. Nekal is an artificial soap, produced by condensation of naphthalene sulphonic acid with isopropylalcohol and similar compounds, these being by-products of synthetic methanol. In the same line falls the Protectol of the Berlin Anilin works, which is the liquor obtained from the sulphite-cellulose process. Protectol enables wool and silk to be dyed with sulphur dyes without damaging the same. The tendency to facilitate the dyeing process is also demonstrated by the fact that vat-dyes are appearing on the market, not only in reduced state (paste of the reduction product being soluble in water), but also in the new colloidal form. This form is particularly suitable for expensive products like the thioindigos, because the losses through bad reduction are reduced to a minimum.

Scientific activity in the field of artificial dyes is astonishing, but the critical reader cannot help being impressed by the many hopeless attempts to find substitutes for certain irreplaceable and first-class products. Of late most of the old dyes of the well-known indanthrene series have been perfected so that the shades are much more brilliant and often more resistant towards light and chlorine. This applies especially to the Indanthrene Brilliant Blue of the I.-G. and some similar dyes. The most important product is doubtless the wonderful Caledon Jade Green of the Scottish Dyestuffs Corporation, which shows that even the remarkably well-organised German I.-G. can miss one of the best "aces." Whilst the anthraquinone series offers no peculiar interest for the moment, in spite of the very many patents taken for anthraquinone and perylene dyes, the indigo series seems to yield some quite new and unexpected results.

New Dyes

The Society of Chemical Industry in Basle and the Farbwerke vormals Höchst (now I.-G.) have found that excellent results may be obtained by combining the benzene-indigo type with the naphthalene-indigo type, making use at the same time of the famous discoveries of Friedländer's thioindigos. The new vat-dyes vary from red to blue and brown, and some of the new compounds are extraordinarily resistant in every respect. The new Ciba browns belong to this series. Some old dyes, which were too expensive in earlier days, have reappeared, because to-day every price will be paid, provided that every wish is fulfilled. Helindone violets of different constitutions, and the wonderful Helindone Rose FF by the same firm and Cassella in Mainkur are examples. The Cibanone Green B of the Society of Chemical Industry, which has just made its

appearance, is a combination of the anthracene series and the ordinary benzoic-indigo series, showing remarkable solidity in every respect. Some of the Cibanone and Chlorantine light dyes, on the other hand, represent entirely new types. Cibanone Orange R, Chlorantine Light Green B, and Chlorantine Light Blue 8 GB are representatives.

The largest field in aniline dyes is still occupied by the azo dyes, which were invented in England by Griess some seventy years ago. In spite of great activity, the only really first-class product which has appeared in recent times is the famous Naphthol AS series. It is the only cheap competitor of Alizarine Red (turkey red), and the work of "Griessheim-Elektron" (now I.-G.). It marks an epoch in easy and very fast dyeing. The Naphthol AS is marked by the fact that the mordant (naphthalene and aniline derivatives) has such affinity with the fibre that drying is not necessary before the development with the diazo-salt. Another step towards simplification is marked by the Neolan dyes of the Society of Chemical Industry in Basle, which are soluble combinations of chromium oxide and the mordant colour. These excellent dyestuffs exist in many varieties, and we wait for a Neolan black and Neolan brown. Neolan colours dye the shade desired and do not have to be after-chromed at all. A new mordant for basic dyes is Katanol (Cassella), a condensa-

tion product of phenol and sulphur chloride. The other groups of artificial dyes include also some new examples. Hydron Blues and some new types of the Wool Fast Blue series may be named which leave nothing to be desired except the reddish shade in artificial light (Berlin Dyeworks).

Among the smaller groups I may mention the beautiful Astraflloxin FF of the Bayer Dyeworks, which belongs to a quite new type of aniline dyes. These colours may replace rhodamine, which formerly was considered as unsurpassable. They have been developed in Höchst and give excellent results. They render the photographic emulsion so sensitive towards green and yellow light that coloured kinema pictures seem within the reach of possibility.

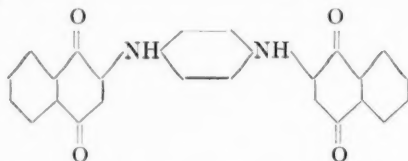
The important problem of dyeing acetate silk has been solved in an unexpected way. Since it has been recognised that practically every dyestuff soluble in benzene or alcohol will dye celanese or acetate silk very many compounds have come forward. The complicated methods which have been proposed for the dyeing of acetate silk have already been superseded, and the silk dyer has practically every shade desired at his disposal. Even the elegant method of Arthur Green, who invented the Ionamines (BDC), is no longer required, because much simpler basic dyes will answer the purpose.

Dyes and Their Application: Recent Technical Progress

By L. J. Hooley

Dyeing Wool with Vat Colours

ANILINE, naphthalene, diamines, benzidines, and other amines will condense readily with benzo- or naphtho-quinones to form arylidoquinones of which the following may be taken as an example.



These arylidoquinones may be vatted and the one shown gives shades fast to washing.

In a sense, some of them are intermediate between the vat colours and the complex substantive azo dyes. On heating, treating with halogens, with condensing agents and especially with sulphur compounds, other derivatives are obtained. These generally contain additional rings formed through sulphur and nitrogen atoms. They are more valuable than the starting materials and are suitable for dyeing wool. The discovery of these wool colours dates from about 1911 and is attributed to Maag. The first products on the market were Helindone Yellow CG, Thioindigo Yellow GW, and Helindone Brown.

Their essential advantages appear to consist in formation from cheap starting materials and in the fact that they are very easily reduced and can be prepared in stable leuco form.

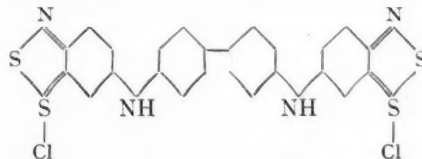
A short time before the war, Meister, Lucius, und Brüning brought out some of these colours, and in a pattern sheet "Vat Colours on Wool," about fifty shades are illustrated, obtained from five colours, Helindone Yellow CG Vat, Helindone Brown CM Vat, Indigo MLB Vat I, Helindone Black B Vat, and Helindone Red BB Vat. These, as can be seen from the titles, are in the vatted form, the red probably belonging to the thioindigos. Since then a very large number of derivatives of varied structure have been protected, the constitution of many of which are doubtful. Several of these have already been described in THE CHEMICAL AGE, and among more recent ones the following may be mentioned.

New Patents

B.P. 258,563 S.C.I.B., in which diarylido benzoquinones are treated with a mixture of sulphur halide and halogen.

In B.P. 245,623, azine bodies are obtained by the condensation of *p*-quinones and phenazines, followed in some cases by oxidation. These products do not contain sulphur or not necessarily so.

Cassella, who have synthesised a large number of these compounds suitable for wool dyestuffs, describe in B.P. 265,641 intermediates obtained from arylenethiazthionium chlorides. By the action of sulphur dichloride on *o*-toluidine, by the method of an earlier patent, 6-methyl-4-chloro-2:1:phenylene thiazthionium chloride may be obtained. This and similar substances are condensed in this patent with bases such as aniline and benzidine. The product from benzidine is shown below.



Reduction converts these to ortho amino mercaptans which form the starting-point for wool dyestuffs, being condensed with quinones to form products which are stated to be of unusual brightness and fastness.

Preparation of Reduced Dye in Powder Form

These colours have been put on the market in solution, but are now sold in the reduced powder form. Although their preparation consists roughly in vating the colour and then evaporating the vat along with hydrosulphite and alkali, the essential part of the process is carrying out the drying so that no oxidation takes place and a porous dry mass remains, which will grind to a fine powder, easily soluble in water. For this reason the drying is usually done with one or more of a variety of assistants, such as molasses, sugars, sulphite cellulose liquor, soaps, carbonates, borates, lignin sulphonic acid, Turkey Red oil, etc. Drying by hot air in the atomised condition has also been proposed.

In setting up the dye bath, a little hydrosulphite and ammonia are added to the bath, to account for dissolved air and any of the dyestuff which may have become oxidised.

The following are some of these wool colours which have been put on the market: Helindone Black B, R, P, Helindone Brown C3R, CR, EB, Khaki C, Red BP, CR, Lananthrene Black, Brown and Red, Wool Vat Blue, Brown, Violet, etc. Some of these are undoubtedly indigo colours, and in reducing properties the two classes are very similar, giving pale yellowish vats, so that the arylidoquinones are easily mistaken for indigos.

Indigo itself has, of course, always been used in enormous quantities for wool. The other indigos are also very suitable for wool dyeing, as they can be employed from practically

neutral baths when necessary. They have not, however, been used very much for this purpose.

Antraquinone Vats on Wool

The anthraquinone vats are the most difficult to apply, not, of course, that the actual dyeing is any trouble. This takes place just as readily as with cotton, if the same method is adopted, and probably many experimenters, tackling the problem of wool vat dyeing for the first time, have been surprised by the apparent ease of it, especially if they have had little experience with wool and are ignorant of the finer properties of handle, etc. A number of attempts have been made to get over the alkalinity difficulty by using protecting agents in the bath, or by first vatting in normal strength alkali and then reducing the strength of dyeing. Many of the methods involving the use of protecting agents are only suitable for indigo colours or for wool scouring. B.P. 209,949, Morton Sundour Fabrics and J. Thomas, describes dyeing with a large variety of anthraquinone colours.

There is little doubt that some objections to using these colours on wool are based on imaginary difficulties. The case of silk has been very similar, but a large number of the

anthraquinone vats are now used regularly by the larger silk dyers, and the use is increasing. At the present time some very determined trials are being made by wool dyers to use vats. Demands are being made for fast pale and medium shades which are only possible with the anthraquinone series. The British Dyestuffs Corporation have recently put out "Vat Colours on Wool," for which they have used a mixed selection of Durindone, Duranthrene, and Caledon Colours. The Caledon Colours most suitable for wool dyeing are those which can be used from a small caustic vat, *i.e.*, principally the cold dyeing ones. The method consists essentially in first vatting the colour outside the bath. The dye bath is then set up with just a trace of alkali and hydrosulphite, and the wool entered. As regards protecting agents opinions differ, but they can be dispensed with. As the dyeing is carried on with rather a small margin of alkali and hydrosulphite, it is necessary to avoid unnecessary agitation of the liquid surface. It will also be appreciated that if the colour is not properly vatted outside the bath, there is even less chance of it vatting inside, where the concentrations of the reducing agents are so much lower. The process is otherwise much the same as for cotton.

Dyestuffs Markets: The Month's Business in Review

From Our Own Correspondents

Lancashire

Business in dyestuffs during July showed little diminution, but there are signs of the normal slackening effect of the holiday season.

It is reported that some arrangement has been arrived at whereby the British Dyestuffs Corporation, Ltd., is to manufacture certain of the calico printing specialties of Durand and Huguenin of Basle. It is understood that Bard and Wishart will continue as heretofore the sole selling agents in Great Britain for such specialties.

During the month, rumour has been very busy as to widespread business arrangements in the dyestuff world. Whether there is anything definite behind the rumours it is difficult to determine, but a most interesting feature of the talk has been the agreed acceptance of the soundness of such an arrangement, which rather points to the fact that the time for it to take place is opportune and ripe.

The cotton trade still remains in an unsatisfactory state; the Shanghai auctions have been stopped on the decision of the Foreign Bankers' Association only to deliver goods against cash in the case of native orders; inquiries from India are many, but at prices too low for business to take place; the Cotton Yarn Association is being considerably hampered in its attempt to curtail production by firms which did not join the Association.

Meanwhile, as anticipated in last month's report, this season's boll-weevils are stated to be more widespread than ever, and prices of the order of a shilling a pound for American cotton are confidently predicted in some quarters. At this date it is becoming obvious that something much more fundamental in character will have to be attempted if the cotton trade is ever to become healthy again. There can be no doubt that lower prices would bring some business back, and one move seems to be with the banks which are deeply involved, and another seems to be with the spinners, weavers, bleachers, dyers, and finishers who, by one means or another, should fuse their divided interests into one, namely, the welfare of the cotton industry.

Yorkshire

Holidays have now arrived to add their quota to influences operating against trade, and the colour manufacturer remembers their effect on the trading of the months of July and August in previous years' budgets for diminished turnovers. In Dewsbury and Mirfield, for instance, the closing down of a large number of the mills for the whole of the last week of July proved a great hindrance to some of the leading firms who were experiencing a distinct spurt both in the home trade and overseas orders. The present state of the industry is probably better than at any time during the last two years. In Huddersfield the position does not improve with the rapidity expected, although the woollen section is better placed than the worsted. Piece dyed goods are not selling well, practically all the demand being for fancies.

Early in July a meeting was held in Leeds of the committee of the English Serge Manufacturers' Association, when reports were presented of the progress of the scheme for launching a publicity campaign for increasing the demand for indigo blue dyed serge. Sufficient encouragement had been received from members of the trade to warrant the organisation going ahead and sufficient funds guaranteed to cover initial propaganda and the instructing of an advertising company to prepare a plan of campaign.

Dewsbury lost one of its leading industrialists and philanthropists, and its only Freeman, in the death of Sir Mark Oldroyd on the 5th of last month at the age of 84. His association with the firm of M. Oldroyd and Sons, Ltd., one of the largest woollen manufacturing firms in the kingdom and of world-wide reputation, covered the greater part of his life and was crowned by a royal tour of Spinkwell Mills, the largest manufacturing premises in Dewsbury, and one of the firm's three factories, when the King and Queen visited the heavy woollen district in 1918.

A public company, registered under the title of "Solignum, Ltd.," the nominal capital of which is £150,000 in 100,000 shares of £1 each and 200,000 ordinary shares of 5s., has acquired from Major and Co., Ltd., the goodwill of the "Solignum" branch of their business, and will carry on the business of manufacturers of and dealers in chemicals, dyes, etc., and tar distillers.

Scotland

Business has again been quite good in Scotland as a whole. The Glasgow holidays began on July 15 and lasted from a week to a fortnight, depending in individual cases on the actual orders in hand; there were not many cases of extension of the normal period because of slackness, however. It seems possible that conditions in Scotland are just a little better than in England, and dyestuff sellers have noticed a little falling-off in the latter orders, while the home ones have kept up.

Employment in the dyeing and bleaching trades is still as good as it was last month, and printers, who were not sharing the good fortune to any great extent last month, are busier now. The tendency of the last few years in favour of brighter colours, which is still on the increase, is, of course, a factor in favour of the dyer.

The woollen industry, especially tweeds, continues in its present very satisfactory position. Orders are good and the export trade active. Wool spinning in the Greenock and Ayr districts is not so good. The hosiery section is fairly moderate and is busiest in the fancy goods section. A recent bright idea, which the Scottish hosiery manufacturers are hoping to exploit to the full, is the short woollen golf stockings, to be worn over silk stockings, instead of the usual all wool stockings.

Speaking generally, conditions in Scotland have been very steady these last three months, with little signs of any change in evidence.

Dyestuffs Monthly Supplement

Published in the second issue of "The Chemical Age" each month

Communications relating to editorial matter for the Dyestuffs Monthly Supplement should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Advertisement matter, subscriptions, etc., should be sent to the Manager.

The Supplement is devoted to the interests of both manufacturers and users of dyestuffs, and contributions will be welcomed.

B.D.C. Selling Agencies

A REORGANISATION of the various selling forces of the constituent companies of Imperial Chemical Industries, Ltd., is announced by our Lancashire correspondent. It is stated that, although it takes the form of a unification of the various selling organisations in any one district, the dyestuff consumer will, in the main, be served by the same personnel as heretofore. The policy of maintaining efficient technical services, of which the British Dyestuffs Corporation make a special feature, is to be maintained. The commercial directors of the I.C.I. are to be congratulated on the consideration which has been given to the complex and unique relationship which exists between dyestuff manufacturer and consumer, and the scheme will do much to allay any fear that may have existed that a section of the I.C.I. of enormous importance to the textile industries would be more or less lost sight of among the more profitable and larger interests of the company. It is expected that similar reorganisation will take place abroad, and this should prove a considerable aid to the export business of the British Dyestuffs Corporation, inasmuch as the latter will be able to take advantage of the excellent and efficient world-wide selling organisation of some of the larger companies.

The New Price Factor

THE new price factor recently decided on by the Dyestuffs Licensing Committee—namely, the substitution of 2 for 2½ times the pre-war price—came into operation on September 1. When the change was announced, we published a number of representative opinions from various points of view on the effects likely to be produced. While some of the manufacturing interests regarded the change as somewhat abrupt and as not allowing dyestuff makers reasonable time to recoup themselves for their heavy expenditure on research, the general impression was that the industry would be able to accommodate itself without serious inconvenience to the new price standard. For some time past, improved production methods and sales organisation have tended to cheapen manufacturing costs, and the new price factor will tend to stimulate these efforts towards increased efficiency. In spite of the depressed state of the textile industry, our information is that the dyestuffs trade is not unsatisfactory; one very large concern, we believe, has up to now better returns than for some time past. The users, too, in spite of their constant demand for cheaper dyes, are doing well. It is obvious that home producers will make an effort to work to the new price standard, because, if they fail, they will correspondingly open the home market to foreign dyes. The new price factor has not been in operation long enough yet for its effects to become apparent; in another month or two it may be possible to judge from definite experience.

The Problem of "Fastness"

THE rapidity with which the problem of "fastness" has come to be recognised as of first-class importance in the production of dyestuffs is distinctly striking. When we began drawing attention to the public interest it was attracting in America some months ago, it seemed almost an academic matter. Some of the higher-class firms,

like Sundour Fabrics, were, it is true, already emphasising the fastness of their dyed materials as something almost exceptional, but in a large class of business no sort of guarantee was given. Almost suddenly, the importance of permanence in colour is recognised by the textile industry, by the dyestuff makers, and by research workers, and the problem is undergoing intensive study, as the discussions at Leeds this week show.

One of the most important documents on the subject is the report on research work on the fastness to light of dyestuffs on woollen and worsted fabrics, prepared by the British Research Association for these industries. This is a work of great thoroughness and of real importance. It is divided into ten sections. Already some conclusions of value have been definitely reached. For example, the present system of artificial fading does not agree in results with those obtained from actual sunlight, and fading in the tropics is actually less than at country stations in England. Increase of colour loss, again, with increase of humidity is found to be an important variable in fading conditions. A standard humidity for all fading tests is considered essential. Increasing the amount of ultra-violet radiation on the pattern results in an increase of fading, and the ultra-violet has a more violent effect as humidity increases.

Dyestuff Discussions at Leeds

AT the Leeds meeting of the British Association, the subject of dyestuffs has come up for discussion at various points, perhaps the paper of most immediate interest being that of Dr. S. G. Barker on the fading of dyestuffs, to which frequent reference has been made in our columns of late. The historically minded journalist, in his researches into the Leeds meeting of 1858, has unearthed the paper that Mr. W. H. Perkin presented in that year on the new dye he had obtained from coal-tar. This was probably the first public contribution on the discovery, and the official abstract of the paper is worth quoting:—

This dye, a specimen of which was exhibited, is a product of the oxidation of aniline by bichromate of potash. It is a bronze-coloured substance, dissolving in alcohol with a beautiful purple colour. It is difficultly soluble in water, but more soluble in acidulated water. Like indigo, it is perfectly decolourised by the hydrated protoxide of iron, the colour being restored again by exposure to the air. It dissolves in concentrated sulphuric acid, forming a green solution which, upon the addition of water, precipitates the colour unchanged. It is not affected by digestion with an alcoholic solution of potash. It decomposes slowly at 250 deg. C. It is applicable for dyeing and printing silk, cotton, or wool. Its colour is exceedingly intense, one pound of the solid substance dyeing no less than 200 lb. of cotton a moderate dark lilac. The colours thus produced are very permanent, standing the action of light and heat, acids and alkalis. Samples of silk dyed with it were exhibited.

This new dye, which Perkin named "Mauve" and a laboratory sample of which is in the possession of the British Dyestuffs Corporation, had been discovered two years earlier when, 18 years of age, he was laboratory assistant to Hofmann and a student at the Royal College of Science. He had been trying to synthesise quinine and had found a sticky substance forming which he could not crystallise.

Hofmann advised him to throw it away, but Perkin continued his efforts, which resulted in the production of the first aniline dye. Perkin was so impressed with the possibilities that he left the College in order to begin manufacturing the dye, which was put on the market in 1857.

Textile Problems at the B.A.

DURING the meeting of the British Association special sessions were held for the discussion of textile subjects, and a garden party was held at the headquarters of the Research Association for the Woollen and Worsted Industries. From an inspection of the work now in progress it is clear that rapid advances are being made. A Guild colorimeter has been installed for colour matching. Incidentally it appears that the results yielded by this instrument are of great value, but that before the measurements can be regarded as absolute a special correction must be applied to eliminate the personal errors (due to differing types of vision, etc.) of the operator. As appeared from some of the papers read at a meeting at the Association headquarters, a sound knowledge of the effect on dyed fabrics of differing intensities of sunshine in air of varying humidity is being developed. It is no longer necessary, when preparing goods for a foreign or overseas market, to dye them with the first dye that comes to hand, in the hope that it will serve the purpose. By a knowledge of the sunlight and humidity conditions prevailing in the particular district for which the goods are destined, it is now possible to choose a dyestuff that will resist the influences to which it is to be subjected. The gain in security and certainty is obvious.

Analysis by Ultra-violet Radiation

THE Research Association is doing much work on the use of ultra-violet light for testing purposes. By means of a specially designed apparatus, any specimen may be subjected to the action of the ultra-violet rays, and results may be rapidly obtained. Various textile fibres show up differently, and may be thereby differentiated. Indigosol dyes on fabric, when incompletely developed, fluoresce strongly, differing in this respect from the fully developed dyes; and so on. Though the instrument has only been in use for a short time, it has already proved its value. In order to realise its possibilities completely, it will be necessary, for example, to employ it in the examination of samples treated with a large number of different dyestuffs, in order to determine to what extent it may be used for purposes of classification and analysis. This instrument has been developed by Mr. H. R. Hirst, working in conjunction with Dr. Barker.

Reference should be made to the sheep-branding material ("B.R.A." fluid) developed by the Association, which is very successfully fulfilling the function for which it was designed—namely, the marking of sheep without permanent damage to the wool.

Visit to Hickson & Partners

AMONG the activities of the Chemistry Section of the British Association were included visits to various dyestuff works. At the works of Hickson and Partners, Ltd., of Castleford, the visit began at the lead-chamber sulphuric acid plant. This, the largest single unit of its kind in the country, turns out many tons of brown oil of vitriol per week. Subsequently visitors were shown the complete series of operations involved in the manufacture of a dyestuff, namely: the distillation of the crude benzol received from the gasworks or coke ovens for the production of benzene, toluene, etc., the nitration of the hydrocarbons obtained to give various nitro-derivatives, the reduction of the nitro-derivatives to amines; and finally the conversion of the latter to the finished dyestuffs.

Among the processes shown was the production of rosaniline. One of the most interesting products on view was para-dichlorobenzene. It is well known that some of the substances which are used (or have been used) as moth-repellents and insecticides do not really function effectively. Recent work has shown that para-dichlorobenzene has both the above properties in a very high degree, and it is being used in large and increasing quantities, not only for the protection of clothing, but also as a means of destroying plant pests. Hickson and Partners are supplying this substance in a form suitable for use in gardens, etc.

L. B. Holliday & Co.

ON Monday the Chemical Section of the Association visited the works of L. B. Holliday and Co., Ltd., of Huddersfield, makers of dyestuffs and kindred products. Major Holliday, in a short speech of welcome, pointed out that the works were only ten years old. One of the first (and most interesting) things seen by the guests was the plant for the production of ethyl-, diethyl-, methyl-, and dimethyl-anilines from aniline and the appropriate alcohol, heated in the presence of a catalyst. The intermediates thus produced are of great importance and represent a distinct achievement on the part of the firm. The production of a number of dyestuffs—magenta, methyl violet, etc.—was seen, and in this connection the production of thio-indigo deserves special mention. A direct black vat dyestuff for cotton, viscose, etc., which also gives black shades for printing, has been evolved by the company's research department, and was the object of much attention. A substance outside the dyestuffs, namely, diethyldiphenyl-urea, which is being produced in large quantities, also attracted a great deal of interest. Incidentally, the attitude of the modern dyestuff manufacturer towards his wares was exemplified by the presence, in one of the laboratories, of a fadeometer (for testing the fading of dyestuffs when exposed to light), which is in very regular use. The varied needs of the works were emphasised by the existence of a large refrigerating plant, capable of producing tons of ice per day for use in various processes.

Dr. G. T. Morgan was among the visitors, and in thanking the firm for their kindness in showing their works to the members of the Association spoke reminiscently of the days when he had been a chemist in the works of Read Holliday and Sons, when he had known the father of Major Holliday. In those days, he said, when the research chemist *did* get some results, he was usually told that all the plant he could have for production on the works scale was a "a stick and a tub." He deplored the fact that there was still the view prevalent among ignorant people in this country that all good dyes were necessarily German, and appealed to the members of the Association present to help to break down this defeatist idea by disseminating the real facts more widely.

Dyestuff Licences for August

THE following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during August, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 600, of which 505 were from merchants or importers. To these should be added 16 cases outstanding on July 31, making a total for the month of 616. These were dealt with as follows:—Granted, 540 (of which 521 were dealt with within 7 days of receipt); referred to British makers of similar products, 47 (of which 37 were dealt with within 7 days of receipt); referred to reparation supplies available, 5 (all dealt with within 2 days of receipt); outstanding on August 31, 1927, 24. Of the total of 616 applications received, 563, or 91 per cent., were dealt with within 7 days of receipt.

The Standardisation of the Fastness of Dyestuffs

Dr. Barker's Paper at Leeds

Special sessions for the discussion of textile and related subjects were held at Leeds during the meeting there of the British Association for the Advancement of Science. Among the papers was one on "The Standardisation of the Fastness of Dyestuffs," which was read by Dr. S. G. Barker, director of research at the British Research Association for the Woollen and Worsted Industries. The paper gave a long and exhaustive account of recent work done at the headquarters of the Association, at Leeds, and some of the more important points mentioned are indicated below.

Of all attributes of textile fabrics that which most readily contributesto the æsthetic sense is their colour or coloured pattern. It has recently been stated that there are about 3,000 dyewares in use at the present time, and it cannot be denied that the British dyestuff industry is now firmly established. At the outset it must be remembered that "dyeing" is not only a science, but that the old-time method of nomenclature as the "art of dyeing" is equally true. In this regard attention must be given to the unknown variable factors such as the varying selective affinity of wool fibres for dyestuffs, etc., which have to be remembered and corrected directly by experience and judgment of the operator.

The importance of the standardisation of fastness of dyestuffs to the influence of various external agencies has been realised throughout the ages, but recently the matter has assumed a much greater importance in view of wider ranges of shades and the number of dyestuffs used. The standard of fastness has changed with time, and recently F. Schofield pointed out that "Indigo was, until the beginning of this century, the standard for a 'fast' blue on cotton as on wool; the introduction of vat dyestuffs of the indanthrene class has made indigo by comparison a fugitive colour."

Action Taken in Various Countries

In Germany, as early as 1911, the "Echtheits-Kommission" of the German Chemical Society set up a committee with the object of preparation of standards of fastness, and recently, in 1926, has published a third edition of its report. In America the work has been undertaken by the American Association of Textile Chemists and Colourists, and the tests are being carried out at the Bureau of Standards. Speaking generally, the American tests adopted differ from the German standard tests. It is thus evident that if standardisation is to be attained, the first step will be to attain some measure of international agreement.

In England the matter was left to the enthusiasm of individual workers until last year, when the far-sighted policy of the British Research Association for the Woollen and Worsted Industries and the Society of Dyers and Colourists was announced. This Society decided that the colour users of this country must also have a voice in the selection of standards and classification of dyestuffs, and therefore formed an influential research committee to formulate and carry out a scheme of work on the subject. With their customary zeal this scheme is now organised and well on the way towards realisation. The Colour Laboratories of the British Research Association for the Woollen and Worsted Industries have been asked to co-operate in the work, and the Research Association has been delighted to offer to carry out the experimental work involved.

It has recently been pointed out that in this country there is no technical institution where colour users can turn for advice and to have tests carried out under standard conditions. The British Research Association for the Woollen and Worsted Industries has recognised this fact, and recently has equipped and staffed a laboratory for colour work and testing, of a technical character, built up on a sound scientific basis. The latest optical apparatus has generously been placed at its disposal by Adam Hilger and Co., Kelvin, Bottomley and Baird, and other firms, so that it is equipped with the most expensive and up-to-date means of testing, whilst active help and advice has with equal generosity been placed at its disposal by the leading authorities of the world, including Mr. John Guild, of the National Physical Laboratory; Professor Martin, of Imperial College; the Clarendon Laboratory, Oxford; The Bureau of Standards, Washington; and Dr. Paul Kraus, head of the German Dyestuffs Commission. It is thus hoped to build up the technical colour-testing centre of the Empire in this laboratory.

In contrast to the usual methods, the question of standardi-

sation of dyestuffs in this country has been preceded by a large amount of research work conducted by the Research Association and others. The problems in Dr. Barker's paper were not approached from the chemical standpoint in the usual sense, but were confined to the discussion of recent work in the colour laboratories of the British Research Association for the Woollen and Worsted Industries and elsewhere, connected with the most important of tests, the fastness to light.

In all tests of fastness three main problems are predominant:

- (1) The fastness and durability of a colour to the influence of external conditions.
- (2) The choice of a standard source of illumination for the fading of patterns.
- (3) The determination of the exact shade of a colour, and its correct representation or description.

Fading experiments have been done in the tropics, in town and country in England, and with standard artificial fading lamps in the laboratories of the Research Association. Except in the case of the fadeometer the procedure was the same at all stations. The patterns were mounted on strips of card, and covered, so that three sections were made on each pattern. Each section could be exposed by tearing off the card and black paper covering. The first section was exposed to full sunlight for two weeks. The cover was then removed from the second section, and this was exposed for a period of two weeks alongside the first section. The patterns in this condition were carefully packed and returned to the Association for testing purposes. During the time of exposure, daily, and in most cases hourly, records were taken of sunshine, humidity, and cloud formation. They thus had exact information as to the conditions.

Classification of Types of Fading

The results of the work immediately led to the conclusion that fading could be catalogued under three headings:

- (1) Simple loss of colour, *i.e.*, the faded fabric would be of the same hue, but the fading would tend towards the white.
- (2) An actual colour change to a different hue. On analysis of certain colours after exposure to light it was found that the amounts of the various constituent colours had increased and others decreased, so that a new mixture of different hue from the former one had been formed.
- (3) A loss in brightness, but not loss in colour, *i.e.*, the fabric looked dull.

These three kinds of fading were readily distinguished in the experiments now recorded. Obviously it was a fairly simple matter to place the colours under heading (1) in an order of fastness, but groups (2) and (3) certainly present a difficult problem. It was also evident that colours in group (2) would be unsuitable for making up dye mixtures, for after exposure to light an entirely different hue would result.

A further point to note was that when stating the fastness to light of any colour it was obviously of little value to give degrees of fastness for one particular saturation of the colour. The only method which would give useful results was to express the percentage loss of colour for dyeings made with different amounts of dye, increasing from the palest shade to the fullest. This method was particularly valuable when dyes were used for compound shades. Such numerical expressions would enable a dyer to select colours which would have equal degrees of fastness for the amounts of colour used, so that fading of the fabric would be equal in hue, and no colour would predominate because it was too fast. The use of too "fast" dyes as one component of a mixture would naturally cause the faded material to deviate from the normal shade of the garment, and just in the same manner one fugitive dye in the mixture would give an equally undesirable result.

Further, if a single dye or mixture of dyes when faded actually changed in hue, the result would be more unpleasant

than a more fugitive dye which simply became paler, and the resulting contrast would be less objectionable.

In order to compare the fastness of each colour the following procedure was adopted. The total percentage loss during the whole time of exposure was taken, and the colours placed in order of loss. The patterns were then numbered in this order. This procedure was repeated for each station, and thus was obtained an order of fading for each set of exposures. A table was compiled showing in vertical columns the position of the dyestuff in the fading list at each of the stations. The average of the different readings gave the mean position of fading at all stations.

The amounts of fading of each dyestuff at the different stations were examined, and interesting results accrued. It was seen, for example, that in a typical case for Indigo Carmine the curves showed widely different amounts of fading for the same period of exposure at the various stations. Various reasons could be ascribed.

- (1) Difference in constitution of sunlight in the ultra-violet.
- (2) Difference in altitude.
- (3) Difference in atmospheric conditions.

As regards the former, there was the possibility and probability of the factor being effective in making a difference between tropical and home fading, although this could not explain the whole difference. With reference to the second factor, it was noted that the fading at Trivandrum, which is almost sea-level, was practically the same as at Kodaikanal, 8,400 ft. high. That at Bangalore, however, which is about the mean height between the two stations above mentioned, was considerably less.

The fadings were done in full sunlight at the same times in each place. It was therefore obvious that they must turn to the third variable as an explanation of the difference in fading—namely, atmospheric conditions. A perusal of the relative tables showed that the average relative humidity at Trivandrum and Kodaikanal for the period of exposure was almost the same, namely, 61.4 per cent., whilst for Bangalore the relative humidity was only 41.5 per cent. If the values were taken for the percentage losses at the two stations for a number of the patterns, it was seen that there was a rough proportionality between the relative humidity of the surrounding atmosphere and the amount of fading.

Effect of Moisture on Fading

Dr. Barker stated that they had already observed in a previous paper that a dry fabric did not fade, whilst the same fabric when wet faded rapidly, but no definite relation could be ascribed. It was thus possible that in the case of dyestuffs the degree of fading depended on the amount of moisture in the adsorbed layer on the fabric. If this was the case, and since a relationship existed between the amount of the water and the relative humidity of the atmosphere, it might be suggested that some relation held between the degree of fading and the relative humidity.

The precise effect of humidity and its relation to fading was now being systematically investigated, but the outstanding fact remained that a colour might be perfectly fast in a dry atmosphere or in a moderately damp one, but would fade rapidly with increase of humidity. It was essential, therefore, that all tests of fastness of dyestuffs should be done under standard conditions of humidity, otherwise the fastness could not be guaranteed if the fabric was taken into atmospheric conditions which differed from those under which the test was made.

A case in point had recently been brought to their notice. A manufacturer placed a dyed fabric in the open air for one week in full sunlight, and no fading was perceptible. The same goods exposed in a shop window in Huddersfield faded in three days, and were returned to the maker. The weather being warm, the shop in which the fabric was exposed had been artificially humidified by water, perspiration from customers' bodies, steam pressing, etc., so that the internal conditions were ideal for fading. The humidity had risen so high that this, combined with the sunlight, had caused the fading. In a drier atmosphere the fabric would certainly have been fast enough under ordinary conditions.

The observation of strict care of humidity conditions in the exposure and storage of dyed fabrics was essential. It had also been remarked that fabrics exposed behind glass faded more rapidly than in the open. The atmospheric conditions surrounding the fabric were probably the factors to be considered in such cases.

Further evidence of the influence of humidity was shown in an experiment with the fadeometer. A top was fitted to the instrument, and a fan placed above it, so that there was a constant circulation of air through the apparatus. The water bath at the bottom dried up more quickly, and the result of increased humidification of the patterns was increased rapidity of fading. Experiments conducted with different fadeometers showed considerable variations of humidity with each instrument, and consequently considerable variations in fading. It was thus an essential in tests with a Fadeometer that rigid conditions of humidity should be imposed, otherwise unreliable results would be obtained. It was probable that if due attention was given to this factor and also to the standard conditions of voltage and amperage laid down for the apparatus that the fadeometer results would prove of great value.

They had been working on modifications of the instrument in order to secure these standard conditions, since it was undoubtedly a necessity that some rapid testing method be devised, and the violet carbon arc was the nearest approach to sunlight that they had at present. An experimental instrument had now been delivered for testing purposes, and would be on the market soon. A recent paper by Hedges on atmospheric humidity and the fading of dyestuffs had shown the importance of the part played by the humidity of the atmosphere in connection with the rate of fading of dyed fabrics. This humidity factor probably accounted to some extent for the fact that dyes had more "returns" on account of fading at Whitsuntide than in August.

A New Book on Colour Mixing

Textile Colour Mixing. By David Paterson, F.R.S.E., F.C.S. Pp. 137, with over 50 illustrations, coloured plates and dyeings. London: Ernest Benn. 12s. 6d.

The author is to be congratulated on the appearance of a third edition of *Textile Colour Mixing*. It is nearly thirty years since the first publication, and the previous edition has been exhausted for some time. As befits a handbook on colour, it is attractively written and broadly treated. The standard is quite sufficient for the purpose of ordinary textile colourists, and while the physical basis of the treatment is sound, it is almost self-explanatory and entirely non-mathematical. There are a large number of spectroscopic diagrams to illustrate the text, and this, indeed, forms one of the book's best features: it would have been an advantage if one or two of these could have been coloured. The book is a companion volume to *Colour Matching on Textiles*, with which it should be read. From the theoretical point of view, the development of the theory of colour mixing is sufficiently general to be of value to anyone dealing with colour, whether concerned with textiles or not. For this reason the title may suggest less general interest than the book actually possesses. The coloured patterns are better mounted than in the previous edition, but two of the coloured plates have been taken out. In giving the names of dyestuffs, capitals are not used (except for brand marks), thus *lissamine green B*, and not the more usual *Lissamine*. The book is of very convenient length, and is an excellent introduction for anyone interested in colour. The printing and binding are up to the usual standard of the publishers.

United Indigo and Chemical Co.'s Report

In their twenty-eighth annual report, the directors of the United Indigo and Chemical Co., Ltd., Manchester, state that, including a balance of £14,170 8s. 9d. brought forward from last year, there is a profit of £36,063 8s. 1d. Of this £7,500 has been paid in dividends at 5 per cent. on the preference shares for twelve months to June 30, 1927, and £2,187 10s. has been paid on the ordinary shares, at the rate of 5 per cent., for the six months up to December 31, 1926, thus leaving £26,375 18s. 1d. for allocation. This the directors propose to allot as follows: £2,187 10s. in payment of dividends at 5 per cent. on the ordinary shares, up to June 30, 1927, £5,625 in dividends on the preference shares at 3½ per cent., and £3,281 5s. in a further dividend on the ordinary shares at the rate of 3½ per cent. There is thus £15,282 3s. 1d. to be carried forward to next year's account. The annual meeting will be held at Accountants' Chambers, 60, Spring Gardens, Manchester, on September 14.

Pigments for Colouring Portland Cement Mortar

Results of Recent Research

The use of colour in conjunction with Portland cement is showing a tendency to increase, owing to the widespread use of stucco and the recognition of concrete as an architectural as well as a structural material. Until recently there was little specific knowledge of these colouring materials available. Investigations at the research laboratory of the Portland Cement Association, Chicago, have produced certain data, which are summarised by Mr. James E. Foster, in "Chemical and Metallurgical Engineering."

A TOTAL of 264 pigments of the following types of chemical composition are being used:

Buff and yellow:

Iron oxide (ochre, sienna, artificial hydrated iron oxide) ..	53
Cadmium lithopone (cadmium sulphide and barium sulphate)	5
Zinc chromate	1
Organic colour on an inert base	1

Red:

Iron oxide, natural or artificial (over 85 per cent. Fe_2O_3) ..	60
Iron oxide (less than 85 per cent. Fe_2O_3 , remainder natural impurities)	47
Iron oxide, extended with calcium sulphate	27
Organic colour on an inert base	9

Green:

Chromium oxide	85
Mixture of chromium oxide and ultramarine blue	21

Blue:

Ultramarine blue	22
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Brown:

Iron oxide	15
Iron and manganese oxides, umber	18
Iron oxide and carbon	8

Black:

Carbon black	41
Coal or coke	19
Iron oxide	9
Bone ash	5
Manganese dioxide	5
Unidentified	1

From this it may be seen that approximately 69 per cent. of the pigments studied were either wholly or partially iron oxides and that more than 77.3 per cent. are essentially made up of oxides of iron, manganese and chromium. Furthermore, in each class of hues, with the exception of blue, there was at least one group of this type of pigment.

With these pigments classified according to chemical make-up a series of tests was started in order to determine:

- (1) The tinting value of commercial pigments.
- (2) The relation between chemical composition of pigments and the colour permanence of mortar exposed to natural climatic conditions.
- (3) The effect of pigments on the compressive strength of mortars.

Data of the tinting value of different pigments were secured by observing the colour of the hardened mortar. Colour permanence was determined by exposing specimens to the weather on a rack which faced the south and was tilted at an angle of 40 deg. and comparing them after a given period of time with similar specimens kept in a dark, dry place. The effect of pigments on compressive strength of mortar was studied by determining the crushing strength of cylindrical specimens 2 in. in diameter and 4 in. high, containing varied quantities of representative pigments.

Tests made in which the proportion of a given pigment was varied showed a reasonably uniform hue except in those cases where the quantity of pigment was so low as to have a negligible effect on the colour of the natural mortar. By the use of both white and grey Portland cement, it was found that in some cases practically the same colour of mortar can be produced in light grey cement as can be obtained in the white material, provided that a larger quantity of pigment is used.

With the red, yellow, green, and black pigments there was very little difference in colour between specimens in which the pigment equalled 35 per cent. of the weight of the cement,

and those in which it equalled 50 per cent. The ultramarine had not, according to Mr. Wilson, apparently reached its limit at a 50 per cent. admixture (ratio of pigment to Portland cement by weight).

As an added amount of pigment has in practically all cases a negligible effect on the resulting colour, the quantity used should for purely economic reasons be limited. For practical purposes an admixture of 20 per cent. may be accepted as a maximum. The minimum is obviously 0 per cent. The exact proportion of pigment to cement must be determined specifically by the hue, chroma and value desired.

In the case of blacks, the tests showed that one unit of carbon black is approximately equal in effect on colour to five units of iron oxide black. This does not necessarily mean that carbon is the better pigment, as will be seen further in this paper, when the compressive strength of mortar is discussed.

The specimens exposed to natural conditions were studied after periods ranging from two weeks to six months. The most important change in the colour of a mortar due to fading of the pigment caused by weathering was a progressive weakening of the chroma. Accumulation of dirt and soot results in a lowering of the value, and, no doubt also plays some part in causing the chroma to become weaker. In the tests so far made, the mortar discs were not washed after exposure, but the colour studied was that found on them when they were removed from the exposure rack. One interesting observation in this connection was that after a hard rain the value appeared to be somewhat higher and the chroma slightly stronger.

The tests seem to show that if a colour is not permanent, it will fail after a short period of exposure. Colour determinations showed comparatively little change in the chroma of most specimens after two months, and in cases where the pigment failed within six months, this failure was either complete or definitely indicated at two months. Aside from those pigments which failed completely, no differences in the degree of permanence of pigments developed during six months of exposure.

Pigments with Permanent Colouring Properties

The following types of pigments showed permanent colouring qualities as a result of the six months' exposure:

Buff, yellow and red: iron oxide.

Green: chromium oxide.

Blue: ultramarine blue.

Brown: iron oxide, or iron and manganese oxide pigments.

Black: iron oxide, manganese dioxide, carbon black, bone ash and the so-called mineral blacks (coal, coke, and certain unidentified carbonaceous materials high in mineral matter).

The cadmium lithopones faded to a faint yellow during three months of exposure. After twenty-eight days the mortar coloured with organic pigments had only traces of its original colour.

These failures are attributed to the fading effect of sunlight, and not to any chemical action of the cement. This conclusion is based on the fact that the surface of these specimens assumed colours comparable to that of uncoloured cement, while below the surfaces the colours were not greatly changed. This conclusion is further confirmed by the fact that the discs kept in the laboratory in the dark underwent no changes.

A zinc chromate failed because of chemical reaction with the cement. A 5 per cent. admixture of this pigment caused quick stiffening of the mortar and the colour faded almost completely within twenty-four hours; mortar containing a 10 per cent. admixture solidified before mixing had been completed. The failures which were encountered with yellow pigments were probably the result of efforts to produce a satisfactory lemon yellow pigment.

In the tests performed to determine the effect of mineral

oxide pigments on the strength of Portland cement mortar, colour admixtures up to 20 per cent. did not produce reductions in strength. The strength of mortars in which ultramarine blue was used increased.

Decreased strength resulted from the use of carbon black. A 2 per cent. admixture of this pigment reduced the strength of the mortar about 15 per cent. and a 4 per cent. admixture was accompanied by a strength reduction of 30 per cent. An iron oxide equal in pigment value to the 2 and 4 per cent.

admixtures of carbon black did not decrease the strength. It is apparent that the oxide is a better cement pigment than carbon.

These conclusions regarding strength in its relation to pigmentation cannot be regarded as absolute, since the number of factors controlled in the experiments were necessarily limited. They nevertheless indicate that a mineral pigment, if used within economic limits, will not seriously decrease the strength of cement mortar.

Dyes and Their Application: Recent Technical Progress

By L. J. Hooley

Dyeing and Printing Methods

Film Dyeing.—An ingenious method of obtaining colour effects of the most varied descriptions has been described by H. Jackson and D. Carter of the British Dyestuffs Corporation, in B.P. 262,601. The colour is dissolved in a solution of nitrocellulose and then poured on to cold water to form a thin film. On dipping the material into this it becomes covered with the cellulose solution. It is dried to remove the solvent and the resulting dyeing will then stand washing with water and moderate soaping. By suitably manipulating the material the film can either be deposited over the whole surface or pattern effects obtained by only colouring it in parts. If two or more solutions are first poured on to the water to form separate films, multicoloured effects can be obtained, which can be varied according to the wish of the operator. The method can be used for colouring almost any object or material and should be particularly attractive to the amateur.

Alkyl Naphthalene Sulphonic Acids.—New assistants for wetting out, solubilisation, etc., are very much to the fore at the present time. Auerbach has measured the relative properties of a number of these (*Textile*, 1926, 681) from observations on the times taken by pieces of dry wool to sink in their aqueous solutions. Oranit, Nekal, and Neomerpin were found to act very satisfactorily, being better in this respect than Turkey-red oil, alcohol, or soda. The alkyl naphthalene sulphonic acids have assumed importance as wetting agents recently. Their preparation has been protected in a number of patents brought out by the I.G.F.A. In B.P. 246,817 butyl naphthalene sulphonic acid is prepared by heating together naphthalene, *n*-butyl alcohol, and sulphuric acid. In B.P. 253,118 the reaction is carried out in a closely similar way, but oleum or chlorosulphonic acid may be used, and examples are given in which the alcohol is ethyl or methyl. These substances may be used for assisting the wetting out of wool, for level dyeing, and as cleansing agents for fulling and bleaching. The metallic salts of these and similar sulphonic acids, e.g., isopropyl naphthalene sulphonic acids, are used for mordanting in B.P. 269,917. These sulphonic acids form soluble salts with chromium, aluminium, and similar mordanting metals. Di-isopropyl naphthalene sulphonic acid is used as an assistant in printing aniline black in B.P. 262,476. The treatment of wool with a solution of one of these acids before the usual carbonising treatment is also recommended for protecting wool against bacteria (B.P. 261,342). These examples are sufficient to illustrate the possibilities of these sulphonic acids.

In comparison with these, it is interesting to see that the alkyl naphthalenes, without sulphonic acid groups, are recommended for lubricating purposes in B.P. 260,604, I.G.F.A.

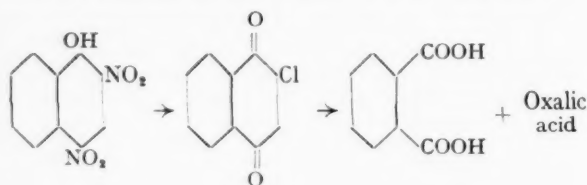
Sulphite cellulose liquor.—Sulphite cellulose waste liquor has found extended use in a variety of dyeing and finishing processes, e.g., for protection in treatments of animal fibres with alkali and in the making up of soluble vat dyes for wool. The Society of Chemical Industry in Basle have now utilised it in the preparation of vat dyes in powder form. These powder vat colours are being increasingly used, as they eliminate the inconvenience of the drying up and settling out which takes place with improperly prepared or handled pastes. Transport charges are of course also less. The powders are prepared in this case by mixing and preferably milling the pastes with the sulphite-cellulose liquor before drying. The object is, of course, to obtain a finely divided

powder which wets out and vats readily. This cellulose liquor has also reducing properties, so that with indigo powders soda can be used in the subsequent vatting. Kotibhasker (*J.S.D.C.*, 1925, 361-2) has investigated this reducing power, using a liquor obtained from Scotch fir and digesting it with a solution containing lime and sulphur dioxide. The resulting solution vatted indigo readily without hydrosulphite. Other colours could also be reduced in it.

Dyeing under pressure.—The use of pressure (two or three atmospheres) is recommended in F.P. 604,448 (M.L.B.) for increasing penetration in dyeing. Nitrogen or carbon dioxide may be used as the pressure gas.

Printing and Discharging.—W. Sieber (*Textile*, 1926, 615) makes a plea for the use of potassium salts instead of sodium ones in printing pastes, there being an increasing tendency to use the latter because they are cheaper. He gives examples with Alizarine, Para Red, and Aniline Black.

Seyewitz and Chaix (*Bull. Soc. Chim.*, 1927, 197) have started an investigation into the mechanism of the oxidation discharge using sodium hypochlorite. They have examined its action on various nitrophenols and amino-nitro bodies. The decomposition products have been isolated and identified. With the nitrophenols and naphthols, chlorination appears to take place first and to be followed by the production of chlorquinones and chloropicrin. With the naphthols, the quinones are further oxidised to phthalic acid:



The discharging of vat colours is generally a difficult matter, especially with the more complex compounds, as they are not easy to destroy without tendering or ruining the fibre. Where discharging is possible it is usually done by reduction methods, which depend more on the production of leuco compounds which can be washed out of the fibre than on the breaking up of the molecule. For the reduction discharge a formaldehyde-sulphoxylate with leucotrope is most effective. Vat colour discharges on vat grounds are, of course, more difficult than white discharges, as the methods have to be based on differences in properties between individual colours, and for this reason it is difficult to get clean-cut whites in plain discharging or clear colours in illumination. Nearly all the methods used depend essentially on the differences between the hot-dyeing and cold-dyeing colours. The distinction is not sharp but generally the latter discharge much more readily. In B.P. 246,183, I.G.F.A., a ground is first dyed with one of the colours of the second class and then printed with a discharge paste containing one of the first, along with sufficient reducing agent to destroy the ground colour and to reduce but not destroy the illuminating colour. No passage through alkali appears to be necessary in this process.

In B.P. 274,178 (S.D.L., J. Thomas, J. S. Wilson) a dyeing or printing is made containing colours of both classes, when on discharging one or more of the colours of the mixed shade is removed and a different shade remains.

Recent Investigations on Dyed Fabrics

The Woollen Research Association's Work

The British Research Association for the Woollen and Worsted Industries is doing much work on the behaviour of dyed fabrics. The account given below is abstracted from the report published by the Association a short time ago, and shows clearly the great complexity of the problem and the manner in which it is being investigated.

THE subject of the fading of dyestuffs is of immense importance to manufacturers, and the British Research Association for the Woollen and Worsted Industries has special laboratories carrying out this work. The first problem to be tackled is to prescribe standard conditions for fading tests. Patterns of worsted cloth, dyed with a wide range of colours, have been exposed to sunlight in the tropics and at home. Pieces of the same dyed fabrics have also been exposed to the light of the carbon arc. The results show that the humidity of the atmosphere at the surface of the patterns plays a prominent part in determining the amount of fading. It can be shown that perfectly dry fabrics show no fading at all, but there is a steady increase in fading with increase of humidity. It is further shown that in the tropics there was actually less fading than in England.

The results show that the present system of artificial fading does not agree in results with those obtained from actual sunlight, and that there was actually less fading in the tropics than at country stations in England. The discrepancy was largely due to humidity conditions in the atmosphere around the patterns. It is essential, therefore, to prescribe a standard humidity for all fading tests.

Under standard conditions the loss of colour has a direct relationship to the time of exposure. This relationship is not linear—i.e., its colour loss is not directly proportional to time of exposure, but in the earlier stages the colour loss is more rapid than later on. An approximate law is proposed in which the loss of colour is proportional to the square root of the time of exposure. The tests indicate that in standardisation of colour fastness, sufficient time should be given to the exposure to allow the fading to be in excess of the initial more rapid fading action. The results of the effect of fading on fabrics dyed with increasing percentages of dyestuffs to secure increasing depths of shade explain the statement that deeper shades are faster than pale shades. It is found that the total colour loss is the same in all cases, so that actually whilst the same loss occurs in all shades, yet this forms a much higher percentage of the initial colour in the case of pale shades than in the case of deeper ones.

Ultraviolet Radiation and Fading

The effect of increasing the amount of ultraviolet radiation on the pattern results in an increase of fading. The ultraviolet has a more violent effect as humidity increases. An examination of the transmissive powers of all kinds of English and foreign plate and window glass, as well as Vitaglass and quartz, shows that the effect of glass in shop windows is to form an effective filter for excluding ultraviolet radiation and thereby decreasing fading power. Fabrics exposed behind glass should fade less than in the open for the same period of exposure under standard atmospheric conditions. Vitaglass is found to transmit the whole solar spectrum. The radiation from gas-filled lamps for shop lighting gives similar results to glass filtered sunlight. The Research Association has evolved a new type of outdoor fading cabinet for mill use, glazed with Vitaglass. The cabinet allows free access of air and atmosphere to the patterns, but eliminates weathering by dirt, soot, and rain. Facilities for meteorological observations are also given.

With a view to forming some idea of the fastness of a dyestuff at various places, humidity and temperature tables have been prepared for the principal countries of the world. The newest form of colorimeter—namely, the Guild Colorimeter—has been installed in the laboratories. For many purposes, however, the Lovibond Tintometer is used, and in order to increase the efficiency of the instrument for comparisons of shade, a special device has been designed by the Research Association known as "The Wool Research Reflector." In this instrument the light is reflected from lightly-ground mirrors so that it falls on the patterns at an angle of 45 deg.

The illumination across the patterns is perfectly even, thus giving ideal conditions for colour comparison.

The general conclusion derived from the work up to date, points to the necessity for the observation of standard conditions of light intensity, temperature, and humidity at the surface of the pattern, during the exposure for test purposes. These conditions are now attained in the new fading lamp designed by the Association.

The effect of exposing acid, neutral and alkaline worsted to sunlight shows that after exposure all the patterns are distinctly acid. These, if then carefully neutralised, and equal weights dyed together along with an unexposed neutral pattern in the same bath, give entirely different results. The dyes selected for this purpose roughly illustrate the different types of wool dyes. There is a different affinity of wool for dye after the various treatments. Wool is readily modified by reagents so that it absorbs dyes from a dye bath more or less readily.

One of the greatest difficulties in the manufacture of white flannels and worsteds is contamination with iron, either from machinery or water; such goods when bleached appear perfectly white, but on exposure to sunlight rapidly turn brown. A contaminated piece of cloth was exposed under a stencil and in order to preserve the pattern, the oxidised iron was developed with potassium ferrocyanide, with the result that a permanent photographic print was recorded.

Observation of Colours

Certain combinations of dyes used to produce fashionable shades have the peculiar property of changing their hues when illuminated with ordinary artificial light, so that the ordinary sources of illumination are useless for colour matching purposes. In order to meet this difficulty, special lamps have been devised, so that the light from the electric bulb passes through a coloured glass plate or filter. This latter is so designed that it filters out the particular coloured rays of light which are present in excess when compared to North daylight, and by this means the true colours can be seen or matched when daylight is not available.

In order to render colour comparison easier and more accurate the Research Association has designed spectacles of special glass. If the pattern is illuminated with artificial light from a lamp with an opaque globe and viewed through these spectacles, a close approximation to daylight illumination is obtained. The Research Association has also designed spectacles of Crookes glass, specially made for textile workers. The wearing of these glasses eliminates the eyestrain so common in the mending rooms of textile factories.

Wool is particularly liable to damage by bacteria and moulds when the conditions of temperature and moisture content are favourable. Unfortunately, during the manufacturing process of yarn and fabrics, these unfavourable conditions largely prevail, and it is frequently difficult to prevent damage. Tens of thousands of pounds sterling are lost annually by this cause. The Research Association considered that this was so important that they have given much time to the study of the so-called mildew, with a view to ascertaining the exact conditions where damage is liable to occur, and to find means for the prevention of the same. They have been successful in finding reliable and cheap methods whereby wool may be rendered immune from damage, and as an outcome of the investigations they have found that some of the more obscure effects of bacteria have caused considerable loss due to the modification of the protein matter of the wool fibres, whereby its affinity for dyes is materially altered, and have thus been able to prevent another great source of trouble, namely, uneven dyeing. They say that these investigations have led them to a more profound and careful research on the properties of wool and its behaviour towards other reagents, such as acids and alkalis.

Dyestuffs Markets: The Month's Business in Review

From Our Own Correspondents

Lancashire

August, always the dulltest business month in the year, has lived up to its reputation. From comparison with previous years there is no reason to believe that there has been any exceptional falling-off.

The shilling cotton men have proved to be right, with the result that the shares of such companies as are known to carry large stocks in one form or another have seen a sharp advance in price. It may well be that balance sheets in such cases will show larger profits, but the increased price for cotton will not help to put into operation the idle 30 per cent. of available spindles, nor does it help to clear the issues which are involved in the attempt to stimulate Britain's greatest industry.

It is interesting to note that the formation of the Cotton Yarn Association is bringing to the surface many of the fundamental weaknesses of the cotton trade. Many suggest a childishness and an ignorance which are pathetic; others are of a character which will test the metal of the leaders of the industry before they are eliminated. The conferences of the various interests which will take place during September will, it is hoped, clear the air and lead to a plan of campaign which will have the confidence of the brains in the industry.

A reorganisation of the various selling forces of the constituent companies of the Imperial Chemical Industries, Ltd., is reported. It is stated that, although it takes the form of a unification of the various selling organisations in any one district, the dyestuff consumer will, in the main, be served by the same personnel as heretofore. The policy of maintaining efficient technical services, of which the British Dyestuffs Corporation made a special feature, is to be maintained.

The commercial directors of the I.C.I. are to be congratulated on the consideration which has been given to the complex and unique relationship which exists between dyestuff manufacturer and consumer, and the scheme will do much to allay any fear which may have existed that a section of the I.C.I. of enormous importance to the textile industries would be more or less lost sight of among the more profitable and larger interests of the company.

It is expected that similar reorganisation will take place abroad, and this should prove a considerable aid to the export business of the British Dyestuffs Corporation, inasmuch as the latter will be able to take advantage of the excellent and efficient world-wide selling organisation of some of the larger companies.

Yorkshire

August, the holiday month, not expected to yield much in the way of turnover, has been better this year than was expected, but, nevertheless, the trading accounts bear the indelible stamp of somewhat decreased demand. The textile trade in the Dewsbury district has been quite good, tweeds required for sports garments being one of the busiest lines, and there is a growing demand for medium and heavier classes of tweeds for suitings and overcoatings. Further, orders for the winter season's trade are now well in hand and in good quantity. Capital is being laid out in the form of up-to-date plant. Increased business is being done with Japan.

The great majority of the Huddersfield operatives last month deserted the air of the weaving shed for the more salubrious air of the seaside, and it is well that the exodus occurred when trade was anything but brisk. Trade is patchy, and no marked improvement is anticipated before the early months of next year. Some of the fine worsted mills are active; others are not so. So far as the winter trade is concerned, the more striking hues and designs for overcoatings are not as much in demand, and suitings show a tendency to revert to a quieter fashion. The year is likely to show a better result than last year, but that is poor consolation when one considers what a year the last one was.

The reduction in the price of petrol which took place last month was the third in a few months, and the effect of the series in the price of benzol is shown by the lower quotations of to-day. While appreciable per gallon of benzol, the effect on the production costs of intermediates per lb. is scarcely noticeable, and users of these products should not look to the

reaping of immediate benefits. Further, the maker realises that it is a good deal easier to drop the prices of his wares than to raise them, and that the chances of a jump upwards in the price of petrol, with a sympathetic jump in that of benzol, are not altogether remote.

The British Association opened its meeting in Leeds on August 31, and it is fitting, considering the locality, that matters pertaining to textile technology should have been allotted an importance in its proceedings. Members of the Chemical Section of the British Association at Leeds paid visits on Friday, September 2, to the Yorkshire Coking and Chemical Co., Ltd., Glass Houghton, to the works of Hickson and Partners, Ltd., Castleford, and L. B. Holliday and Co., Ltd., Huddersfield, thereby following the processes of coal-tar colour production from coal through the intermediates to the finished dyestuffs.

Scotland

Business has managed to hold up fairly well in Scotland during August, considering that the holidays are not yet over. Some travellers have felt that they might have increased their orders but for the difficulty of getting into touch with the principals and directors during this month, and the suggestion has been heard that more business might have been done with samples on the links at North Berwick than round Glasgow.

Dyeing and dyestuff orders are still about the same level as last month, perhaps just a trifle better, while garment dyers are fairly fully occupied. The carpet trade is active, and tweeds and similar branches are still keeping up well. Exports to Germany and America have been satisfactory, but the position as regards the Colonies has tended to counter-balance this, so that exports as a whole are stationary.

Knitted woollen goods are much the same as they have been for the last few months, and would welcome improvement. Among the papers at the British Association meeting at Leeds, two, emanating from the Animal Breeding Research Department of Edinburgh University, have been read by J. E. Nichols and J. A. Fraser Roberts, dealing with the elimination of black and coloured fibres in woollen fleeces.

Edinburgh is to have an exhibition devoted entirely to textile machinery in about a month's time. This is to be held in the Industrial Hall, October 5 to 15, and very substantial support has been obtained.

The United Turkey Red Co. have declared an interim dividend of 3 per cent.; last year there was no interim dividend, and the final was 5 per cent. The Calico Printers' Association have done extremely well to increase their profits above last year's, considering the coal strike, although the figures are, of course, a long way behind those of their very successful year 1924-25.

Annual Report of B. Laporte, Ltd.

In their annual report for the year ended June 30 last, the directors of B. Laporte, Ltd., state that for more than half the period covered by the report the working conditions of the company were adversely affected by the coal strike. The extra cost of fuel and motive power alone amounted to over £10,000, and none of this was passed on to their customers. In addition, output and sales during the strike period suffered considerably. With the return of more normal conditions in January of this year, it was again possible to manufacture their products on a reasonably profitable basis. In view of all the circumstances, the directors consider the profits earned and the rate of dividend recommended as satisfactory. The works, according to the company's consistent policy, have been maintained in efficient working order out of revenue. The net profit for the year amounted to £11,460, and a dividend of 6 per cent. per annum is proposed on the ordinary shares.

THE I.G. PROPOSES TO PURCHASE 100,000 square metres of land in North West Frankfurt for the erection thereon of a general administration building in which will be centred all the dyestuffs sales organisations, at present located at Ludwigshafen, Frankfurt-on-Main, Hoechst, and Leverkusen.

Dyestuffs Monthly Supplement

Published in the second issue of "The Chemical Age" each month

Communications relating to editorial matter for the Dyestuffs Monthly Supplement should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Advertisement matter, subscriptions, etc., should be sent to the Manager. The Supplement is devoted to the interests of both manufacturers and users of dyestuffs, and contributions will be welcomed.

The Reported European Combine

DURING the current week rumours have been revived respecting an understanding between Imperial Chemical Industries and the I. G. Farbenindustrie. The objects are said to be the avoidance of price competition and the improvement of production methods by the exchange of technical knowledge. The branches of industry to which these principles are expected to be first applied are dyestuffs and synthetic fertilisers, two industries established in this country on their present footing well within the short period of ten years. It is a tribute to the resources of modern British chemical industry that these important branches of industry should have been developed to a stage that makes possible an understanding on equal terms with Germany, in spite of the latter's long start in both fields. No official statement has yet been made on the subject, but the probabilities are all in favour of the scheme. The ultimate objects of this understanding promise to be immensely more important than the immediate effects, important as these are in themselves.

Dyes in Therapeutic Practice

THE researches conducted some time ago by Manchester chemists on the application of dyestuffs to diseases caused by bacteria opened up a new vision of unsuspected benefits to mankind as the result of dyestuffs research. Similar studies, conducted by Dr. Hugh H. Young of the Brady Urological Institute, Baltimore, reveal important results following the use of certain dyes in serious cases of blood poisoning, and, in the words of the author, "hold forth great prospects in the future treatment of infections and infectious diseases."

"Dyestuffs," Dr. Young states in an account of his researches, "have proved increasingly interesting on account of remarkable therapeutic properties. At the Brady Urological Institute, researches over a period of ten years have been made with hundreds of dyes. Efforts have been made to find drugs that were germicidal, non-toxic, non-irritating, and efficient in serum, bile, and other body fluids. Three new drugs have been produced of great value in certain infections, on account of penetration afforded by the dye and efficient germicidal effect. With one in particular, mercurochrome, remarkable efficiency has been shown not only in the local treatment of infections but in intravenous therapy. A 1 per cent. solution is injected into the blood stream in doses of from three to five milligrams per kilogram of body weight. Over 1,000 cases have now been collected of local and general infections, with a high percentage of immediate improvements and many really remarkable apparent cures. In some cases of blood poison, where the condition was desperate, the results have been remarkable.

Why Indigo Dyes Fade

ANOTHER interesting piece of research, conducted by Miss Eva Hibbert, a member of the department of chemistry at the Manchester College of Technology, relates to the chemical action of light on dyed materials. The experiments have been mainly concerned with indigo blue dye, but what has been discovered may be of much wider application. "It has been well-known," Miss Hibbert

states, "that the fading of the dye in cotton and other fabrics has been due to decomposition. What was not known but has now been ascertained is that the product of this decomposition, due to the action of light, is a substance called isatin. We know the composition of isatin, and we can tell how the oxidation proceeds, and this may help us in our further endeavours to obtain really fast colours. Whether we shall be able to eliminate the decomposing element, or whether in other ways it may lead to better methods of fastening colours, remains to be seen. Another important object we have in view is to secure fast colours cheap enough to be of industrial and commercial value.

"Isatin," she added, "is quite soluble and can be washed from a fabric with cold water alone. But whilst by removing this yellow substance the colour will be improved, it will not restore the original colour of the indigo blue, nor will it make it any more of a fast colour. The action of light will still go on producing more isatin, and the fading will continue." The investigation, we understand, is to be extended in other directions.

"Fastness" Problems

THE general recognition that has rather suddenly pervaded the textile industry of the need of some guarantee of "fastness" is already producing a series of secondary problems, which show how difficult the application of an apparently simple principle may become. There is, for example, the position as between the dyer and the merchant where the customer complains that the fastness guarantee has not been fulfilled. A few isolated cases may not matter, but where the transaction affects a considerable bulk of dyed material, the dyer is placed in a serious position if the merchant decides to throw the whole responsibility on to him. The attempt that is now being made to set up a series of standardised tests of fastness are intended to meet such difficulties. The task is not easy, because the degree of fastness to light, for example, may be seriously affected by atmospheric influences such as humidity, and colours quite fast to light in one climate may become fugitive colours in another. Ultimately, no doubt, the problem will be solved, but in the meantime it would seem desirable to fix more definitely the meaning and limits of any "fadeless" guarantee, so as to cover the time factor and the variation in conditions. One suggestion is that instead of an absolute guarantee of the kind often seen, there should be a guarantee that certain dyes definitely recognised as fast colours have been used. This would give the intelligent dealer a precise idea of what he could guarantee to his customer, and where those dyes were not used, his guarantee, if retained at all, would be correspondingly weaker.

The Need of Technical Men

THIS, however, implies a certain amount of technical knowledge, and the introduction of the technical man to supplement qualifications of the ordinary business type. This point is very well put by an authority who advocates a sound technical training for those who have to deal with questions of this kind. "If the townsman," he writes, "who knows nothing about his dyes continues to control

the conditions of contracts for dyeing, his employer must take the consequences. And if the dyer considers that by employing a young man fresh from college as his 'chemist' at 30s. a week he is in the van of progress, he will find his mistake. There are plenty of men available who can rapidly be trained, under suitable conditions, to deal with the technical problems in question, but it may be better to do without them altogether than for them to be subordinated to the townsman who will take an order at undue risk. The extraordinary thing is that responsible positions and living wages are allotted to unqualified men, while men requiring no more wages and with good qualifications are looking for work. A scientific training is somewhat of a disqualification at present, due more than anything else to the man being regarded as a specialist and 'therefore' not a business man! He must be kept in his laboratory! But, with apologies for this diversion, may I raise the question as to whether those who give orders to the townsmen or dyers are fitted for their jobs? Do they recognise that they have much to learn, or are they satisfied to think that any good business man is good enough? This I know, that the most experienced merchant who gives orders for dyeing is the one who best recognises his own shortcomings in knowledge of dyes and dyeing."

American and Canadian Examples

It is interesting to compare this demand for technically trained men in this country with current opinion in America and Canada. The *American Dyestuff Reporter*, in discussing this subject, says: "Modern mill owners recognise the rare virtues of plain, honest hard work. But along with experience and ability to work they require of their important men a technical education. Almost invariably the men they employ to manage their mills have been technically trained. And these managers, realising that their training has helped them more than anything else to advance, naturally employ superintendents and overseers who have also been technically trained. This demand for men with a technical textile education extends down the ladder even to the ranks of assistant dyers, bleachers, finishers, and other workers. The American textile industry has pinned its faith to the growing army of technically trained experts that now form the sturdy framework of the personnel in every progressive mill. It is upon these technical men the industry is relying to improve and perfect its manufacturing processes, that it may squarely meet the competition in the world's markets, and it is upon the technically trained men that the industry is bestowing its best positions and its honours."

The following comment, again, on Canadian mill equipment is made by the *Canadian Colorist* in some notes on the equipment of Canadian textile mills: "A mechanical dye house is now closer to attainment than ever before. Real temperature control is helping many dyers to do better and faster work. While all the losses that are charged to dyeing operations do not properly belong there, many can be reduced and the dyer can prove his point when he has good standard equipment under scientific control. The range of work possible depends on the equipment. Some managers expect a dyer to produce anything from a few simple direct colours. Some dyers, through inexperience, are afraid of the newer and more complicated dyeing processes. They should be given opportunities to learn new methods and should be aided by chemists when necessary."

The Position of the Small Maker

THE American dyestuff industry is following very closely developments in this country, and the sympathy expressed with the small independent manufacturer in the face of

large combines, reduction of price factor, and other conditions is almost pathetic. One authority declares that it must be the innate British pluck that forbids the smaller British dyestuff manufacturers from emitting a louder wail over their distressing predicament. Quoting from THE CHEMICAL AGE an opinion expressed by the Clayton Aniline Co. that the effect of the cost of the dyestuff on the selling cost of the finished fabric is negligible, it remarks: "A sound, sensible argument! It calls to mind what has been reiterated so often in this country (the United States) regarding the cost of dyes in fabrics, and agrees perfectly with the findings of our Tariff Commission, which last year made a study of these costs. But is it not plain that the lot of the small British dye-producers is certainly not one to be envied? Their home markets dominated by a powerful rival, their prices depressed lower than at any time since the war, and their endeavours belittled by a disgruntled consuming trade, is it not surprising that they have not set up a louder wail for justice and fair play? They might even be justified in believing, at times, that they are in worse straits than their American brethren."

We are not sure that the British independent maker will too readily recognise his own portrait in these words. At any rate, though sensible of many difficulties, he is withholding his tears.

Imported Dyestuff Prices

MR. FOX, the alert United States Trade Commissioner in London, reports to his department in Washington that, although the average prices for British produced dyestuffs are not available, the following figures, compiled by a leading trade association, show the average selling prices of imported coal tar dyestuffs, and give an indication of the general trend of prices, an increase in the average price per pound being noted in 1926 over the corresponding 1925 figure. This increase, he states, is explained largely by the use of better grades of dyes rather than by price increases, as in fact there have been a number of price reductions during the year as compared with 1925.

Year.	Pence per lb.	Increase over 1913 per cent.	Tons.	Value per lb.
1913	11.7	—	18,394	1,892,055
1920	79.2	577	10,397	7,552,799
1923	49.8	326	2,808	1,004,482
1925	42.99	267	1,981	646,903
1926	47.94	310	1,892	876,529

The figures in the "Pence per lb." column are exclusive of alizarine and synthetic indigo, but the tonnage and value statistics include them.

Dyestuff Licences for September

THE following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during September, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee:—

The total number of applications received during the month was 651, of which 512 were from merchants or importers. To these should be added 24 cases outstanding on August 31, making a total for the month of 675. These were dealt with as follows:—Granted, 598 (of which 562 were dealt with within seven days of receipt); referred to British makers of similar products, 64 (of which 48 were dealt with within seven days of receipt); referred to reparation supplies available, 2 (all dealt with within two days of receipt); outstanding on September 30, 1927, 11. Of the total of 675 applications received, 612 were dealt with within seven days of receipt.

Some Aspects of Fading and Fastness

By a Dyestuffs Chemist

In fastness properties the resistances of a dye to light and washing are the most important. Although these two often go together, they really depend on quite different properties. Lack of fastness to washing need only mean that the dye is easily removed from the fibre, but if a product fades under exposure to light, this is because it has been decomposed. However, in speaking of the fastness of a dyestuff it is usually the light fastness which is referred to primarily, and light fastness can quite conveniently be considered by itself.

Without going systematically into the causes and results of light fading, some special aspects can be examined. In addition to the light and dye, there are also influences such as air, the fibre and small quantities of other substances or impurities present, for which allowance must be made. Of these the air and traces of moisture are the most important. In some cases it has been shown definitely that there is actual absorption of oxygen, and different oxidation and other theories have been put forward, but the constitutions of dyestuffs themselves are too varied and fading is affected too much by circumstances, such as time of year, source of light, place, and condition of the atmosphere, for the process to be the same in each case or to expect one explanation to cover the whole.

Light Absorption and Fading

Fading, of course, comes under the heading of photochemical action, and the mechanism of this has not been investigated to anything approaching the same extent as with ordinary chemical actions, where the effects are due to heat rather than light. It is, however, possible to connect the phenomenon of fading with that of colour production. A dyestuff molecule may be regarded as a machine for absorbing certain constituents of white light. The energy of the light absorbed has to be converted to other forms, as it is not, of course, emitted as light of a different colour except in cases of fluorescence. The energy is probably largely converted to heat, but it is unlikely that the heat formed is primarily responsible for the decomposition of the dyestuffs, as this usually requires moderately high temperatures. The mechanism of the light absorption depends on the presence of oscillators in the molecule, *i.e.*, parts of the molecule capable of vibration. Whether these parts are ions or atoms, or the molecule vibrates as a whole does not immediately matter.

The theory of light absorption depends on the supposition that a dyestuff can absorb light of wavelength corresponding to one of its own periods of vibration. It is possible, of course, that light is necessary to start the vibration, which means that the body is doubly colourless in the dark. In any case, when absorption is actually taking place, the amplitude of the vibration will be increased by the energy absorbed from the light waves. This increase in amplitude means the particle is vibrating further and further from its mean position, and it will be seen that under these circumstances the vibrating parts may move beyond positions or conditions of stability and break away. An analogy to a substance breaking up under the impact of waves corresponding to one of its natural periods of vibration, can be found in the passage of troops over bridges, where as a precaution, step is broken to bring the impulses into different phases. Increase in amplitude may also cause collision with other parts of the molecule to take place. The relation between colour and constitution not being known with any exactness, it is impossible to say definitely what the oscillations are. The vibration may involve almost the whole of the molecule, as in Hewitt's theory connecting colour with tautomerism in long conjugate chains of alternate single and double bonds. Alternatively, electrons may be vibrating between a chromophore and auxochrome, or tracing orbits round the molecule.

Now, a vibrating body always tends to set up vibration in its supports, and unless these are secure they may soon vibrate as much as the original body. A similar effect may take place in a molecule, and this may also cause decomposition. With long chain compounds and compounds in which large portions are only connected through single atoms, the possibilities of disintegration may be much greater.

In this way fastness may be roughly related to general structure. In some of the very fast compounds with compact polycyclic structures, the vibrations absorbing light may possibly be compared with those of stretched strings across rigid supports.

Fading being a photochemical effect, it will only be where light is actually coming into contact with the dyestuff that any action is taking place, *i.e.*, it will generally be practically a surface effect. A very dilute solution of a dyestuff is sufficient to stop the bulk of the light which impinges on it. Solutions used in dyeing, which very often contain less than one part of colour in a thousand of liquor, are usually too dark to see through, so that in the case of a dyestuff in the solid state it is probable that the light is completely absorbed after passing through a very fine layer. If a pound of dye powder were left in a heap in sunlight for a year or two without disturbance, the amount which would be actually decomposed would be negligible. It is, in fact, only because a small amount of dye is distributed over an enormous surface of fabric that fading can take place to the extent which it does.

It must, of course, be remembered that there is the fabric to be taken into consideration. The effect of this is generally only subsidiary, as dyestuffs show approximately the same fastness on all materials. The fabric itself is not a simple substance, and in addition may contain impurities, which were originally present and have not been removed in the finishing treatment or impurities left by the dyeing or other operations. The effect of these may be important; thus cases of fading have been traced to the development of sulphuric acid in a fabric through insufficient washing of a vat colour. The moisture of the air has also an important effect. In this country the strong sunlight, taken on the average, forms only a low proportion of the hours of daylight, and two or three days of strong sunlight are more effective than that of weeks of indifferent light. Experience of the behaviour of colours in this country might suggest that even the best ones would rapidly fade in the tropics. This, however, is not the case, the fastness being greater rather than less, which is probably indirectly due to the lower moisture content.

Fading of Mixtures

Some interesting results are obtained with mixed dyeings. These generally fade in the way that would be expected of them, and the fastness of a poor dye cannot be improved by mixing it with a good one, as the two fade independently of each other. It is, however, sometimes noticed that this does not happen. A mixture of two fast colours may appear to fade much faster than would either alone, or a poor colour may mix with a good one to give a fast mixture. The case of the green from Anthraflavone and Indanthrene has often been quoted as an example of the latter, although in this particular instance it is probably inaccurate. In these anomalous cases it is not clear what is taking place. In the types of case in which, say, a fast blue shows fading when mixed with any one of a large number of yellows, which are of different constitutions and themselves fairly fast, it might appear that the effect was due to a wavelength absorbed by the yellow in some way affecting the blue.

Some anomalous cases are apparent, rather than real. The difference between a 9 and 10 per cent. shade of a blue cannot be detected without close inspection; but if each be dyed in mixture with 6 per cent. of yellow the difference in the greens produced would be unmistakable. Conversely, any difference in the rate of fading of the two constituents of a composite green would be very quickly visible. Other effects can also often be explained in terms of ordinary colour mixing theory. It is sometimes possible to hide a fading tendency in one colour by balancing it with another one.

Fading is not always diminution in colour strength, but sometimes a change in shade without obvious loss in depth. The new shade is then generally a much duller one. Occasionally a perfectly definite change takes place in the course of a very short time to another product which is then quite permanent, although such a compound would not be used as a dye.

Light will convert the undeveloped dyeings of the esters of leuco vat dyes to the normal dyestuffs.

Under uniform conditions of exposure, fading is generally fastest at the beginning, and then gets gradually less, sometimes reaching a stationary state.

With the more permanent dyes, a slight initial fading takes place, and then a state of equilibrium appears to be reached or the rate becomes very much slower. The reason for this is by no means clear. By contrast quite strong shades of basic dyes will bleach quite white after sufficient exposure.

A well-known feature of fading is the very much quicker rate at which pale shades go. Considering the surface nature of the process this is not altogether remarkable, but there appears to be a lack of proportionality. If we assume that the quantity of dyestuff destroyed per unit area per sunlight hour to be constant, then while a 2 per cent. dyeing will have faded to 1 per cent., a 10 per cent. will only have gone to 9 per cent., and the latter will be hardly noticeable. Some good class dyes appear to be indestructible in 10 per cent. shades, while pale tints show quite marked effects.

White substances such as China Clay, sugar, and textiles are often mixed with minute quantities of blue to neutralise yellows and produce good whites. The mechanism of this is logical and understandable. Linen and cotton goods that have to be stored are sometimes wrapped in blue paper with the object of preventing yellowing. Whether it actually has this effect is questionable. So long as the white is in juxtaposition to the blue it will look whiter by reflected blue light, and the action may be only imaginary. If, however, the incidence of blue light prevents the action of discolouring, this may be an effect which will have a counterpart in colour fading.

Standards of Fastness

There has been a good deal of confusion in the standard to be represented by the word fast. Some colours will almost fade in strong sunlight as they are watched. Compared with these, colours which will stand a few weeks of exposure to ordinary diffused sunlight are fast, and considering the very poor qualities of the first aniline dyes, there was some justification for calling the rather better ones fast. This use has, however, tended to debase the word so that when a really good colour has to be described it becomes almost natural to use superlatives to distinguish it from the intermediate class, which is only continuing the confusion. There is, however, a genuine difficulty. While a description implying absolute fastness is hardly desirable, admission of any departure from this ideal in the case of a commercial product would be generally misconstrued as implying a greater divergence from this than corresponded with fact.

So the question arises as to what shall be the practical standard of fastness. Textile goods themselves are not imperishable and if, when an article comes to be discarded, the colour appears to be as good as the day it was dyed, and this without any effort having been taken to preserve it, then any fastness in excess of this is superfluous and in fact valueless. A dyed article which under the most drastic conditions met with in ordinary use shows this behaviour is for practical purposes absolutely fast. Usage, of course, differs so much with different classes of goods that a very much lower standard of dyestuff permanence is necessary with some types of articles than others, but the definition above is meant to apply to colours where the demands are greatest, as, for example, curtains which may have to withstand several years of sunlight.

The fastness of colours in general use has improved considerably during recent years and in some special directions the changes have been almost revolutionary. This is seen most clearly in the guaranteed series of fabrics now available, which represents the movement at its highest. The best of these fulfil the standards which have been laid down. As has already been mentioned in this article, fastness to light only is under consideration, although actually in the question of guaranteed fabrics other factors are of almost equal importance, particularly washing. The basis of these guarantees is generally one of replacement, with sometimes an additional compensation for make-up charges, although this latter is not of any importance in the case of a genuine series. In the reputable series the goods fulfil all that is claimed for them. The percentage of returns are very small indeed with the well-known brands, and are a matter of interest rather than

otherwise. Examination sometimes shows that the returns in question have not been put out by the firm receiving them. Genuine complaints can usually be traced to the dyeing. With vat colours the importance of the soaping treatment after oxidising is sometimes overlooked by manufacturers anxious to cut their processes to the minimum.

It is found as a result of experience that materials stand up very much better to conditions of domestic use than to laboratory testing. Testing is usually made severe, both as a safeguard and also to get results as quickly as possible. A single severe treatment is usually much more effective than several milder ones, and a continuous test shows up weakness more readily than an equivalent interrupted one. There appears little doubt that colours show some power of recovery in the dark or in weak light. This fact has been confirmed in experimental testing.

Improving Standard of Fastness in Dyed Goods

The possibilities of colour fastness at the present time are ahead of general popular realisation. The idea of colours being bound to fade if exposed to sunlight has been so established in the past that in some quarters it is very difficult to displace, and users are only being convinced by their own experience. Consequently the development in the fastest colours has been very much slower than it deserved. Of course the question is complicated, as has already been stated, by the different standards necessary for different articles, and a guarantee not being necessary with certain types of goods obscures the reason for its absolute necessity in others.

Beginning first with cotton and especially casement cloth, the application has spread to all kinds of curtain and furnishing materials, carpets, and other goods. Vat dyes are now being used also on natural silk and on linen and wool. It is only since the war that prints in fast vat colours have been readily available. The results obtained with prints are rapidly increasing in beauty, although the bulk of the more artistic coloured prints on the market are not yet dyed with vats. The shades obtained are increasing in brilliance. In fact there has been a very marked difference in this respect since the war: the more brilliant brands of the vats are being brought out faster than they are absorbed by demand.

One of the most significant developments in the exploitation of the fast colours had been the formation of the Indanthrene Houses, where every article is guaranteed to be dyed with the indanthrene standard of fastness.

In this class of goods there is little room left for further improvement, the difference between complete fastness and the present standard being of little significance. This is not to suggest that dyes are incapable of improvement, but that the margin for improvements in fastness of practical value as regards application to cotton is only a small one. For greater and greater ease of dyeing and printing, elasticity in applying the same dyestuffs to different fibres, and in the possibility of obtaining the same fastness on other than textile materials, there is still plenty of opportunity.

Criticisms are sometimes brought against scientific and technical developments that they bring as many disadvantages with them as benefits, which means that invention outstrips the wisdom applied to its use. The production of colour, however, is free from any possible drawbacks of this kind. The advantages in economy, appearance, and convenience which would follow the production of bright fast colours suitable for all materials and not requiring any protection are obvious. Materials such as brightly coloured raincoats, which have made their appearance during recent years, form a good example of this tendency, as well as representing something which would have been impossible a few years ago.

British Celanese: New Directors

BRIGADIER-GENERAL Sir William Alexander, M.P., Mr. A. Chester Beatty, Mr. R. A. Murray, C.A., and Mr. George Whigham have joined the board of British Celanese, Ltd. Sir William Alexander, M.P., is managing director of Charles Tennant and Co., Ltd., chairman of the Barter Trading Corporation and a director of Celanese Corporation of America and of Canadian Celanese, Ltd. He was formerly chairman of the British Dyestuffs Corporation. Dr. M. Soller, works manager of British Celanese, Ltd., and Mr. G. H. Spilman, manager of the sales department of British Celanese, Ltd., have also been appointed directors of the company.

Basic Intermediates for Dyestuffs: No. XI.—The Amino Derivatives of the Anthracene Series

By "Consultant"

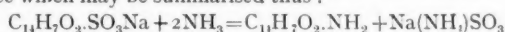
THE simple amino derivatives of anthracene and its various sulphonic acids do not find an extensive use as intermediates for the preparation of dyestuffs, since, for the latter purpose, the derivatives of anthraquinone are not only much more easily prepared, but in addition, give rise to far more brilliant and satisfactory colours, examples of which are to be found in the Indanthrene, Flavanthrene, and similar series.

The most obvious first step towards the production of amino anthraquinone derivatives would appear to be the nitration of anthraquinone; but this, as with the nitration of other quinones, is a difficult matter to accomplish in such a manner that a large yield of a comparatively pure product is obtained. The tendency is towards the production of dinitro compounds, and considerable difficulty is experienced in obtaining good yields of mononitroanthraquinone. The substitution takes place in the alpha or "1" position on direct nitration, giving first α -nitroanthraquinone, and on further nitration a mixture consisting mainly of 1:5 and 1:8 dinitroanthraquinone (49 and 50). The best process for the production of α -nitroan-

solubility in acetone. The crude product is extracted with acetone until a sample of the residue gives a pure blue colour only, on the addition of potassium stannite. Recrystallisation of the residue from nitrobenzene, followed by washing with alcohol, completes the purification of the 1:5 derivative.

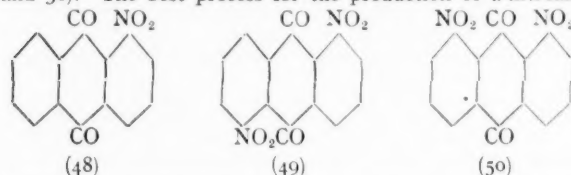
The dinitration mixture can also be made to furnish 1:5 and 1:8 diamido anthraquinone, both of which are of value in the preparation of more complex nuclei, on account of the reactivity of the amino groups. The mixed dinitro compounds (50 lb.) are ground with sodium sulphide solution (containing 1 per cent. of the crystallised sulphide), and the mixture gradually raised to the boiling point. During the boiling, which lasts about two hours, the diamino compounds separate, and, after cooling, are washed with water and dried. The product is ground with a mixture of water (80 lb.) and 98 per cent. sulphuric acid (160 lb.), a further quantity of water (80 lb.) added, and the whole boiled, filtered hot, and allowed to stand twenty-four hours. The sulphate of 1:5 diaminoanthraquinone separates out, is filtered off, and the salt hydrolysed by stirring with a large bulk of cold water. The filtrate from the sulphate of the 1:5 isomer is poured into a large volume of water, and the solid which separates is filtered off, boiled out with water, washed and dried. It contains well over 80 per cent. of the 1:8 diaminoanthraquinone. Purification can be effected through the acetyl derivative. The crude 1:8 diamine is boiled with five times its weight of a mixture of acetic anhydride and glacial acetic acid in equal parts, and after allowing the solution to stand for 24 hours, the solid which has separated (*i.e.*, the diacetyl derivative) is removed, washed and dried. It is hydrolysed by stirring with ten parts of 98 per cent. sulphuric acid at 80° C. for about half an hour, after which the solution, diluted with water, is partially neutralised with ammonia and allowed to stand overnight. The comparatively pure 1:8 diaminoanthraquinone separates out.

It will be readily seen that the direct nitration process only gives rise to the 1-nitroanthraquinone with considerable difficulty, whilst it is not possible to obtain the 2-nitro derivative, at all, by such a method. Hence, for the preparation of the latter compound, and, indeed, for the bulk of the former, recourse is made to a reaction which involves the utilisation of the labile nature of the sulphonic grouping in the monosulphonic acids of anthraquinone; a reaction which is especially valuable since it applies both to the simple sulphonic acids and their derivatives. The sodium salt of the sulphonic acid is heated under pressure with ammonia, when a reaction takes place which may be summarised thus:



If ammonia alone is used, the yield of amino compound only amounts to 50 per cent. of the theoretical, but in the presence of barium chloride, or of an appropriate oxidising agent, the yield may be increased to 80 per cent. in the case of the 2-derivative, and 90 per cent. in the case of the 1-isomer. The function of the barium chloride is obscure. It was at first thought that its action was one purely of solubility, removing the SO_3 radicle as insoluble barium sulphite, but investigation showed that the addition of calcium chloride to the reaction mixture was almost without effect on the yield, despite the fact that calcium sulphite is also insoluble. Further, the addition of a little magnesium chloride to the calcium chloride produced almost the same increase of yield as that experienced with barium chloride.

The actual process used is not very complicated. The sodium salt of the anthraquinone sulphonic acid (either the 1- or the 2-isomer) (10 lb.) is mixed with a solution of barium chloride (6 lb.) in water (18 lb.). Ammonia solution of 25 per cent. strength ($\frac{1}{2}$ cwt.) is added and the mixture heated for 48 hours at 170°–180° C. during which time a pressure of 20–22 atmospheres is generated. The cooled reaction product is removed from the autoclaves and the solid washed with water, dilute acid, dilute alkali, and finally with water. The 2-amino compound which crystallises in red needles is best recrystallised from chlorobenzene, whilst the 1-compound comes out better from xylene. They melt at 302° and 242° C. respectively.



thraquinone by nitration, is that of Ullmann. Anthraquinone (18 lb.) is dissolved in concentrated sulphuric acid (98 per cent.; 1 cwt.) and the solution warmed to 50° C. Stirring having been started, nitric acid of density 1.4 (68 lb.) is slowly run in, the temperature being maintained at 50° C. throughout the whole addition. The batch is stirred until cool, and then run out on to powdered ice. Under these circumstances the crude nitroanthraquinone separates out in the form of a granular crystalline powder which can be easily filtered and washed free from acid. The crude product so obtained has m.p. of 217° C. (*i.e.*, about 13° C. below the normal) and contains some unchanged anthraquinone as well as a little of the mixed dinitro isomers. It is not usual to purify this, since recrystallisation from solvents only effects a very slight purification. In practice the wet paste of nitro compound is reduced straightway with sodium sulphide solution. The yield from the previous operation (about 23 lb.) is ground up with sodium sulphide (32 lb.), the variety containing nine molecules of water of crystallisation being used, whilst boiling water (50 gall.) is slowly added. The whole solution is boiled for twenty minutes and filtered. The residue on the filter is boiled out with water to remove soluble impurities, and is then refiltered. In Ullmann's original description of the laboratory process which corresponds to this operation, the m.p. of the product is given as 243° C., but this is probably intended to mean the m.p. of the much recrystallised product. The commercial grade is usually impure enough to have m.p. 225°–230° C. The yield from the process described above is very good and approaches the theoretical.

If in the process described above for the preparation of 1-nitroanthraquinone, the amount of nitric acid is increased by about 100 per cent. and the temperature is raised slightly, dinitration takes place, producing a complex mixture of isomers, in which the 1:5 and 1:8 dinitroanthraquinones predominate. An analysis of such a mixture showed:—

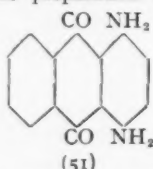
	Per cent.
1:5 Dinitroanthraquinone	37
1:8 Dinitroanthraquinone	37
1:7 Dinitroanthraquinone	4.2
1:6 Dinitroanthraquinone	3.6
2:6 Dinitroanthraquinone	6
2:7 Dinitroanthraquinone	4

Such a mixture can be utilised without separation, for the preparation of Anthracene Blue, and, when required, the 1:5 isomer can be obtained comparatively pure owing to its in-

Several other methods are available for converting the sulphonic acids into the amino compounds, either inorganic or organic oxidising compounds being employed to increase the yield. Thus, in one method 50 per cent. sodium anthraquinone sulphonate paste (100 lb.) is mixed with finely ground 80 per cent. pyrolusite (31 lb.) and water (26 lb.). Ammonia solution of 25 per cent. strength (1 cwt.) is added and the whole heated for 24 hours at 200° C. On cooling, the manganese is removed with bisulphite liquor and the residue of aminoanthraquinone washed with water and dried. The manganese can be replaced by sodium dichromate and ammonium chloride, or by an organic nitro compound. In the case of the latter, an ingenious modification has been devised to produce both metanilic acid and 1-aminoanthraquinone. The nitro compound used is the potassium salt of *m*-nitrobenzene sulphonic acid, obtained by the sulphonation of nitrobenzene. A mixture containing this salt of the nitro compound (31 lb.) together with the potassium salt of anthraquinone-1-sulphonic acid is heated with caustic soda solution (4½ cwt. of 25 per cent. strength) at 160–170° C. for twelve hours. Comparatively pure 1-aminoanthraquinone separates out in the crystalline state on cooling, and metanilic acid can be recovered from the filtrate.

Diaminoanthraquinones

The best method for the production of the 1:5 and 1:8 diaminoanthraquinones is still the reduction method, applied to the mixture obtained by the dinitration of anthraquinone. There is, however, one diaminoanthraquinone of considerable importance, viz., 1:4 diaminoanthraquinone, which cannot be prepared in this way (51). This compound, which finds considerable use in the preparation of Helindone colours,

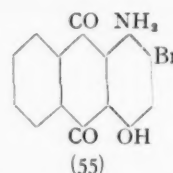
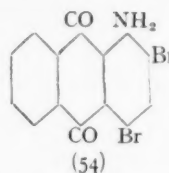
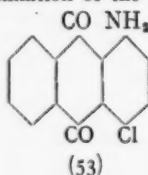
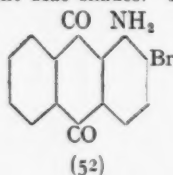


and of Algol Red 5G, which is its dibenzoyl derivative, is prepared by the usual method from the 1-amino derivative—protection of the amino group, followed by nitration and reduction. The method used is as follows: 1-aminoanthraquinone is acetylated by solution in oleum and digestion with acetic anhydride at 30–40° C. until a sample on dilution with water yields a yellow precipitate of the acetyl derivative, and not a red one of the unchanged amino compound. The acetyl derivative (25 lb.) is dissolved in concentrated sulphuric acid (2½ cwt.) at 15° C. and mixed acid containing 20 per cent. of nitric acid (43 lb.) is run in with constant stirring at such a rate that the temperature does not exceed 15° C. Ice (1½ cwt.) is added when the nitration is over, and the 1-acetyl-amino-4-nitroanthraquinone separates in golden yellow crystals. From these the free nitroamino compound is obtained by acid hydrolysis, which proceeds in the same way as that of the hydrolysis of diacetyl-1:8-diaminoanthraquinone described above.

The nitroamino compound is reduced to the 1:4 diamino compound by means of alkaline sulphide solution. The crude product (50 lb.) is stirred into a mixture of sodium sulphide solution (70 per cent.; 100 lb.) and caustic soda solution (25 per cent.; 100 lb.). Steam is blown in until the green solution of the hydroxylamine compound turns brown. After a short boil, brown crystals of the diamino compound are deposited and after cooling may be filtered off and used without further purification.

Halogen Derivatives of Aminoanthraquinones

A number of the halogen derivatives of the aminoanthraquinones are valued for the fact that they give rise to several important blue shades. Direct bromination of the 1-amino-



anthraquinone leads to the formation of 1-amino-2-bromoanthraquinone (52) although the chlorination of the acetyl aminoanthraquinone gives the 4-chloro derivative, from which 4-chloroanthraquinone (53) can be obtained by hydrolysis. For the bromination, the aminoanthraquinone must be reduced to a very fine state of subdivision, an end which is achieved by solution of the crude amine in sulphuric acid and precipitation by dilution with water. The finely divided amine is stirred with 25 times its weight of glacial acetic acid, and the theoretical amount of bromine dissolved in glacial acetic acid is run in. The solution becomes warm and after cooling and dilution with a little water the brom-aminoanthraquinone can be filtered off in a comparatively pure state.

The preparation of the 2:4-dibromo derivative (54) which is used for the production of Alizarine Sky Blue is achieved by the bromination of the free amine at a fairly high temperature. The amine (9 lb.) is dissolved in nitrobenzene (15 lb.) and heated to 150–160° C. and a solution of bromine (15 lb.) in nitrobenzene slowly run in with continual stirring. After the addition stirring is continued at 160° C. for three hours, after which the whole is allowed to cool. The 2:4-dibromoaminoanthraquinone separates out and need only be washed with alcohol and dried. The nitrobenzene solution obtained by centrifuging the reaction product above, can be made to yield a further quantity of the dibromo derivative by steam distillation. One peculiar property of 2:4-dibromo-1-aminoanthraquinone is the extremely labile nature of the 4-bromine atom, which can be readily replaced by a hydroxyl group on warming with sulphuric acid in pyridine solution. The compound so obtained, 4-oxy-2-bromo-1-aminoanthraquinone, finds a use in the preparation of Indanthrene derivatives.

Grays Dyes and Colours, Ltd.

Meeting of Creditors

IN pursuance of the provisions of the Companies (Consolidation) Act, 1908, a largely attended meeting of the creditors in the voluntary liquidation of Grays Dyes and Colours, Ltd., dyeware manufacturers, of Globe Works, Grays, was held on Tuesday, at Winchester House, Old Broad Street, London, when Mr. E. Sudworth, of Wheawill and Sudworth, Huddersfield, the liquidator in the voluntary liquidation, presided. An approximate statement of affairs was presented as at September 13, 1927, which disclosed liabilities of £27,135, all due to unsecured creditors. In addition there were debentures and interest accrued amounting to £23,416. The total assets were valued at £38,786, from which had to be deducted preferential creditors', totalling £809, and debenture holders' claims £23,416, leaving a deficiency of £12,573.

The liquidator reported that the company was registered on May 9, 1919, with a capital of £20,000, divided into 20,000 shares of £1 each. By special resolution the capital was increased in February, 1921, to £50,000, and was again increased by special resolution in May, 1922, to £60,000. An agreement was entered into on July 19, 1921, between the company and Messrs. Brooks and Deacon, who traded as Grays Dyes and Chemical Works, wherein the company agreed to purchase the goodwill, plant, and the whole of the assets of the business for the sum of £24,500. The issued capital of the company was £54,000. The total amount of cash introduced since the formation of the company was £51,500. The company had suffered considerable losses since its inception, the losses on trading having amounted to £52,014.

The chairman said that if he could find anyone to take over the machinery and plant, the creditors should receive a dividend of something like 10s. in the pound; but if it were sold under the hammer the creditors could not hope to receive anything by way of dividend, and it would be doubtful if the debenture holders' claims would be satisfied in full. Very little discussion took place, and eventually one of the principal creditors proposed that the matter should be left in the hands of the present liquidator. This was agreed to.

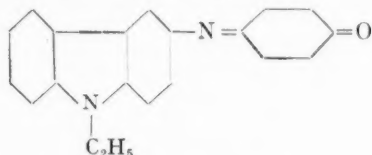
Dyes and Their Application: Recent Technical Progress

By L. J. Hooley

Indocarbon CL and SN

THE two most important disadvantages of the sulphur colours are their weakness to bleaching agents and their tendency to develop acidity, both of which faults may be put down to the ease with which sulphur oxidises. In two of the latest sulphur colours, Indocarbon CL and Indocarbon SN, these drawbacks are claimed to have been reduced to a minimum. These two new products are both blacks, and are said to be the most satisfactory sulphur blacks on the market. As is of course well known, it is for blacks that sulphur colours are most important, and their annual use runs into a weight of millions of pounds. The fastness of sulphur blacks, however, does not compete with that of aniline black, but with the two new colours this inferiority is largely removed, and the use of Indocarbon CL for blacks, but not for greys, is permissible in Germany for goods which are guaranteed to have the indanthrene fastness.

The earlier brands, Indocarbon S, SF and SSF, have been known for several years. When *N*-ethyl carbazole is treated with nitrosophenol in sulphuric acid condensation takes place, giving a compound of the following constitution:—



If this product is melted with sulphur under the proper conditions, the well-known Hydron Blue is obtained, which is fast to light and chlorine. Under different conditions Indocarbon S and SF are obtained, which probably have a related constitution.

Both Indocarbon CL and SN give the usual full shades of the sulphur blacks. The hue of the former is a reddish-black, which can be shaded by a yellow or green sulphur colour—e.g., Immedial Yellow-Olive 5G. The full blue black tone of the SN brand surpasses the shades of this type usually obtainable with sulphur blacks. The CL brand is the faster to bleaching and washing, although not equal to the best of the vat colours. It is also the more suitable for machine dyeing. For bleaching, sodium hypochlorite and not bleaching powder should be used. The dyeing methods are normal.

Sulphur Colours from Carbazole

Other sulphur colours from carbazole are described in E.P. 270,348, S.C.I.B. As for Hydron Blue, carbazole or one of its *N*-alkyl derivatives is condensed with *p*-nitrosophenol and the resulting indophenol is then sulphurised, with, however, the addition of urea and an aromatic base. The melt is purified by extraction with sodium sulphide and with hydrochloric acid. The aromatic bases used may be benzidine, aniline, or the symmetrical urea from *o*-toluidine. The dyestuffs are blue and greenish blue.

The intermediate indophenol from carbazole and nitrosophenol can be obtained in greater purity than normally, by using a low temperature (-4°C .) for the treatment with sulphuric acid (du Pont, U.S.P., 1,628,534).

Orlov and Catchourine (*Ukraine Chem. J. Tech. Sect.*, 1926, 65) have examined the mechanism of the thionation of carbazole indophenols, and conclude that, using mixtures of sodium sulphide and hydrosulphide, it is the former which reacts with the imino-quinone.

Dyeing Sulphur Colours along with Azo Colours

Sulphur and azo colours are not usually thought of together, although they have, however, the common advantages of cheapness and moderate fastness. It is possible to dye them together by combining the oxidation of the sulphur dye with the coupling of a developed azo dye. The I.G.F.A. have patented the production of mixed shades from sulphur and

insoluble azo colours in E.P. 266,387. The process is of advantage, as the brightness of the azo colours is able to supplement that of the sulphur colours, which is usually only moderate. It will probably be most useful in the yellow and red shades, where the sulphur colours are weakest. The bath is made up with one azo constituent dissolved in caustic soda, and the sulphur colour dissolved in sodium sulphide or hydrosulphite; after the goods have been impregnated with this mixed solution they are passed through a diazo solution containing the other azo constituent, when coupling takes place and the sulphur colour is fixed at the same time. Among other examples, a yellowish green is obtained from diacetoacetyl-*o*-tolidine and Immedial Brilliant Green GG with 2,5-dichloraniline.

Cachou de Laval

With their production of a brown dyestuff from sawdust or other organic waste, by heating with sodium sulphide and alkali, in 1873, Croissant and Bretonnière are usually credited with the discovery of the first sulphur colour. Vidal has recently, however, found rather surprisingly that the product does not contain sulphur, although it dyes from a sodium sulphide bath. He has also prepared a similar product without the use of sulphur. Consequently he claims that the first sulphur colours were those obtained by himself in 1893. The point is, however, of historical rather than scientific interest, since far greater importance has always been attached to Vidal's work than to the discovery of Cachou de Laval, and it was the former which stimulated and largely guided investigation into the sulphur colours. In fact, in the twenty years separating the two discoveries the method used by Croissant and Bretonnière attracted very little attention. It is probably too late now, considering the crude nature of the process for the manufacture of Cachou de Laval, to be sure that none of the products obtained ever contained sulphur.

Influence of Copper

Apart from the thionating agent, a number of other substances are used in sulphur melts, as, for example, glycerine, phenol, naphthols and aromatic amines, in order to influence the results. Metallic catalysts also produce important effects, particularly in modifying the shade. Amongst these copper, zinc, iron, chromium, and manganese have all been employed, but copper has been used most frequently. The use of copper is often attended by the production of green shades, but its most successful application has been in the production of colours from the polysulphide melts of the azines, where very much brighter shades are obtained, which are also faster to light. Its special feature in these cases is that it tends to eliminate the formation of blues, and so to produce the rarer and more valued redder shades.

The effect differs according to whether the copper is added at the beginning or end of the process. Brown sulphur colours may be obtained (Du Pont, U.S.P. 1,580,716) by heating an aromatic amine with sulphur, then dissolving in sodium sulphide, adding a copper salt, evaporating to dryness and heating at 300°C . From *m*-toluylene diamine a dye giving shades equivalent to those obtained with cutch may be synthesised.

The formation of copper sulphide in sulphur melts where copper is used may be avoided by using the copper in the form of cuprocyanide, or adding an alkali cyanide along with an ordinary copper salt (I.G.F.A., U.S.P. 1,609,927). This recalls the analytical device for the detection of cadmium in the presence of copper in the group 2 separation.

In U.S.P. 1,568,622, sulphurised products which dye wool in fast green tints are obtained from the indophenols, synthesised from *p*-amino-phenol and *N*-substituted naphthylamines, by treating with sulphites or bisulphites, which convert them to sulphonated derivatives of 1-alkylamino-4-*p*-hydroxy-phenylnaphthylamines. On heating these sulphonated derivatives with alkali polysulphides and copper, dyes giving green shades on vegetable fibres are obtained.

Dyestuffs Markets: The Month's Business in Review

From Our Own Correspondents

Lancashire

The condition of the dyestuff market in September showed little variation from that of the previous month. Fluctuations in the price of cotton during the month have led to a general disturbance and, as there would appear to be little immediate prospect of settled conditions, it seems unlikely that there will be any immediate marked change in the cotton trade, nor, therefore, in the dyestuff trade.

It is reported that the North British Chemical Co., Manchester, one of the smaller dyestuff manufacturing concerns, is to cease manufacture, and it is suggested that some arrangement has been made with one of the larger firms whereby the North British Chemical Co. will be able to continue to supply their regular range of products. The passing of the smaller concerns is almost inevitable, and this in spite of the very considerable pluck and energy which some of them have shown. The fundamental fact is the world's excess of dyestuff plant, which one way or another will have to disappear before it can be said that the dyestuff manufacturers have put their house in order. It is understood that the I.G. either have closed or are in process of closing their smaller factories, and similarly the British Dyestuffs Corporation are concentrating their production in their more modern factories.

The Yarn Association has had an anxious time during the month, during which it has held long conferences with the Federation of Master Spinners in order that agreed action with regard to short time and yarn prices might be secured. In the end agreement has been reached and, although in the opinion of many the objects at stake cannot but be of temporary importance, yet the fact that agreement has at last been reached by a majority of such an important section of the cotton trade as are the spinners on a matter of common interest is an achievement which was necessary before any real constructive work could be undertaken.

Another interesting phase of the movement for co-operation among those interested in the cotton trade is the formal establishment of the Cotton Trade Statistical Bureau, and the constitution of its provisional committee is very welcome reading. Spinners, manufacturers, bleachers, dyers, calico printers, shoppers, and the banks are all represented, and it is the sincere wish of many that such great success will attend their efforts in what might be described as neutral territory as to warrant the extension of the efforts of a similar group into the much more conflicting field of the cotton industry as a whole.

Yorkshire

Promise of better things, a tailing off in actual turnovers toward the end of the month, textile labour unrest, a spirit of optimism with regard to trade recovery, operation of the reduced price factor from $2\frac{1}{2}$ times pre-war prices to 2, a further decrease in the price of crude benzol, maintenance of the high price of phenol, the realisation of Imperial Chemical Industries, Ltd., as such, and the magnificent donation of £100,000 to the Leeds University by Colonel Sir Edward Allen Brotherton, Bart., head of the well-known firm of chemical and colour manufacturers, are some of the features of our industry during the month of September. Further, it is the last of the holiday months, for which, in our earnest moments, we are thankful.

Substantial repeat orders for winter cloths are being booked in the heavy woollen district, doubtless due in part to colder weather experienced; larger quantities of warm material are also on order for Canada. The blanket trade, both white and coloured, is fairly good, but there is less activity in the rag and shoddy trade.

An announcement that the employers in the woollen and worsted industries have given notice to end the existing wages agreement on the wages making-up day in the week ending November 26 has caused a flutter. There is a feeling that if industrial strife is avoided there will be reasonably good trade in autumn and winter. Spring patterns still include much in the way of bright colours, but there is a tendency to quieter shades, especially in men's wear.

Huddersfield trade is patchy. In the fancy worsteds a fair amount of business is being done and quite a good propor-

tion is for overseas. There is a good deal of standing machinery in the woollen trade.

Child of the Department of Overseas Trade, despite its threatened orphanage, the British Industries Fair continues to thrive, and certain dyestuff manufacturers have taken steps towards the arrangement of a co-operative exhibit in the London section of the Fair to be held in February next year.

The reduction of the price factor has not arrived altogether unnoticed by the dyestuff manufacturers. Many dyestuffs, such as sulphur blacks, direct cotton blacks, and colours are not affected because they have long been sold, owing to internal competition, at less than twice pre-war prices, and in some cases at less than cost. The Dyestuffs Act enabled the manufacturer of specialities to subsidise that finely cut side of his business, but now that his powers have been so curtailed by the application and gradual increase of the effectiveness of this instrument, he shows a disinclination to produce those dyestuffs. Already there is talk of "putting up" the prices to the two times level. He has been compelled to make sacrifices in the prices of his specialities from which little comfort can be derived, especially when he recalls the words of the Chairman of the British Cotton and Wool Dyers' Association, Ltd.: "Whilst any reduction is naturally always welcome, the suggested one per lb. of material dyed will on the whole be so slight that consumers will be practically unable to make any concession in their processing charges to customers." Evidently it all goes to the dyer.

Scotland

The volume of trade in Scotland has been well maintained during September, compared with the previous months. In one or two directions there have been minor improvements and very little in the nature of set-backs.

Chemical prices in Glasgow have shown a slight tendency to rise, with a fair demand for home orders, but little business in export. Dyestuffs orders from Scottish sources have kept up fairly well.

In dyeing, the wool dyers are busiest, cotton dyeing and printing being still only moderate, although much the same as during the last month or so. Business has tended to be rather better in the east than the west. The carpet trade has been good.

The border woollen factories are managing to keep up to the same high level, and the position now is distinctly better than this time last year. Orders for tweeds and chevots, particularly fancy varieties, have been quite brisk, and demands for next spring are coming in well. As regards foreign orders conditions differ, some manufacturers reporting business in Japan, Germany, and America, but on the whole there is no doubt that the exports are still unsatisfactory.

Wages have been stabilised in the woollen industry for a further period of six months up to the middle of 1928. At the end of that time, the current wages will have been running for five years.

Scottish and Irish manufacturers have been vigorously opposing in Canada the proposals of the Canadian Government to raise the minimum tariff on linen goods from twenty up to thirty per cent.

B.D.C. Products for Leather

At the Shoe and Leather Fair, held at the Agricultural Hall, London, this week, the British Dyestuffs Corporation, Ltd., showed a new addition to their range of "Coricol" nitro-cellulose pigment leather finishes in the form of a lustre finish, for imparting a silky lustre to fancy and gloving leather. It is stated that it is particularly useful in giving a silk-like finish to articles such as shoes and handbags, in which silk is replaced by light leathers for the sake of durability. Also included among the exhibits were a wide range of fat liquors, oils, and dyestuffs used in the leather industry, there being a display of leathers dyed with direct, acid, basic, and thionol colours. "Necol" products, which are now handled by the B.D.C., were also shown.

Dyestuffs Monthly Supplement

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Communications relating to editorial matter for the Dyestuffs Monthly Supplement should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Advertisement matter, subscriptions, etc., should be sent to the Manager. The Supplement is devoted to the interests of both manufacturers and users of dyestuffs, and contributions will be welcomed.

New B.D.C. Colours

THE British Dyestuffs Corporation announce two new colours—Lissamine Red T and Solochrome Yellow 2G. The former, an addition to the range of acid colours, is described as particularly suitable for the dyeing of wool hosiery yarns and material for knitting purposes generally, owing to its very good penetrating power in conjunction with some fastness to washing. It is dyed, in the manner usual for acid colours, from a sulphuric acid dyebath. The dye, shown on woollen yarn, gives bright and soft tones, varying with the strength of the bath.

Solochrome Yellow 2G, an addition to the range of chrome colours, is applicable to all types of wool materials and is of special interest for loose wool and slubbing, where good general fastness is required. It is of interest also for pieces, owing to the fact that it leaves cotton and silk effects unstained. Its good solubility and levelling power make it suitable for application in the various types of circulating machines. The dye is unaffected by sulphuric acid dye-liquors, and is recommended for carbonised materials.

Dyestuffs Licences for October

THE following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during October, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee:—

The total number of applications received during the month was 846, of which 690 were from merchants or importers. To these should be added 11 cases outstanding on September 30, making a total for the month of 857. These were dealt with as follows:—Granted, 738 (of which 693 were dealt with within 7 days of receipt); referred to British makers of similar products, 86 (of which 64 were dealt with within 7 days of receipt); outstanding on October 31, 1927, 33. Of the total of 857 applications received, 757, or 85 per cent., were dealt with within 7 days of receipt.

Mr. H. S. Smith Honoured

THE announcement that the French Government has awarded the Legion of Honour to Mr. H. Sutcliffe Smith, of Ingerthorpe Grange, Markington, will be received with interest throughout the textile and dye-using industry. Mr. Smith, whose work in connection with the Colour Users' Association and similar organisations has made him a well-known figure, has consistently supported the establishment of a British dyestuff industry. At the same time he has strongly defended the interests of British colour users, and pleaded that, especially in the matter of home dyestuff prices, they should receive the most favourable terms consistent with the maintenance of home manufacture.

I.G. Production of Dyes

THE Berlin banking house of Schwarz, Goldschmidt and Co. have issued a revised reprint of their account of the I.G. and its activities. With regard to dyestuffs, it is stated that "the I.G. Farbenindustrie A.-G. is almost the only concern in Germany that produces coal tar dyes. In spite of the foreign competition which has cropped up in the last ten years, the I.G. with its great experience

still holds the first place in the world. With regard to quantity, the German dyestuff export industry has sustained a great loss as compared with the pre-war period; but, on the other hand, the world market prices for dyestuffs have gone up considerably. In quantity the German export has, since 1913, gone down from 108,000 tons to 30,000–35,000 tons. It has to be considered, however, that 64,000 tons of dyestuffs (not including indigo) had in 1913 a value of 142 million marks, whilst in 1924 22,000 tons (i.e., about one-third) were worth 106 million marks. Even considering the depreciation of money which has occurred since the war by about 40 per cent., an immense augmentation of value has taken place.

"Considering the small production of indigo in the United States (14,000 to 15,000 tons per annum, i.e., 40 to 50 per cent. of the German production before the war) the most important question for the I.G. is to agree with the du Pont Trust and with the other American manufacturers, and also with the English and Swiss producers, on fixing a quota in order that the great indigo exportation to the Far East may not be ruined by further price competition. The Russian Government has announced its intention to buy 70 per cent. of the total Russian requirements from the I.G. In the last few years the Russian import of chemicals amounted to about 65 million marks, of which about 55 million marks have been supplied by Germany."

I.G. Mineral Colours

WITH regard to mineral colours, it is said in the German monograph that "together with the 'Metallbank' (Frankfurt-on-Main) the I.G. now controls more than half of the German producers of mineral and metal colours. The production of lithopone out of zinc ores and barytes in Germany amounts to about 40,000 to 45,000 tons; before the war it amounted to 35,000 tons. The main producers, besides the I.G. (Leverkusen), are the *Gewerkschaft Sachtleben*, now *Silici A.G.*, the *Chemische Fabrik Marienhütte G.m.b.H.*, and the *A.G. für Chemische Industrie*. These firms are controlled more or less by the I.G. alone, or together with *Sachtleben*. The I.G. also participates largely in the *A.G. für Lithopone Fabrikation*.

"Further partners of the 'Lithopone Kontor' in Cologne are the *Chemische Werke vorm. H. and E. Albert*, *Huettenwerke Abraham Wreschner*, *Bourlau and Co.*, and the *Farbwerke G.m.b.H.* The growing importance of the lithopone business in Germany and in other countries can hardly be represented in figures, as we possess no statements regarding the production in this line. However, a comparison may be possible on the basis of some figures at our disposal concerning the U.S.A. The production of lithopone in the United States increased from 109,500 tons, valued at 12.5 million dollars, in 1924, to 145,000 tons, valued at 15 million dollars, in 1925. Besides this the U.S.A. is importing about 10,000 tons per annum. In 1913 Germany imported only 3,100 tons of lithopone white, but exported 17,500 tons; in the first ten months of 1926, however, her import was 17,500 tons and her export 13,250 tons.

"German production of mineral colours is small in comparison to that of the U.S.A. That of the latter is partly due to the excellent propaganda made by the whole in-

dustry. The German industry of mineral colours and lacquers depends on the addition of aniline dyestuffs for the various shades of the natural earth and metal colours, i.e., it is greatly dependent upon the I.G., though recent imports of Swiss and American aniline dyes might make the industry eventually to a certain extent less dependent on the I.G."

The du Pont Celebrations

THE 125th anniversary of the foundation of the great American organisation, E. I. du Pont de Nemours and Co., is an event of more than ordinary interest to chemical industry. The du Pont company was formed at Wilmington in 1802, when the United States was young, and its expansion has kept pace with the growth of the nation. The two most notable developments in recent times have been in connection, first, with the rayon or artificial silk industry, and later with the dyestuffs manufacturing industry. The latter is surveyed by Mr. E. G. Robinson, assistant general manager of the dyestuffs department of the company, in an article, "The Achievements of a Decade in the Dyestuffs Business." "The du Pont dyestuffs industry, into which the company was led during the World War," says Mr. Robinson, "has now reached a stage of development where it can supply the consuming industries of the United States with a large percentage of their needs." Mr. Robinson recalls the early days of the war, when it was reported that dyestuffs were becoming scarce. "People were led to believe that we would all be forced to wear white clothing," he writes. "Due to the foresight and enterprise of the du Pont Company and other companies which undertook the creation of a dyestuffs industry in this country, the catastrophe was happily averted." Mr. Robinson presents many interesting facts concerning the part du Pont has played in making American textile manufacturers and other users of dyes independent, in a large measure, of foreign sources of supply.

U.S.A. Dyestuffs Census

THE tenth annual Census of Dyes and other Synthetic Organic Chemicals, just issued by the United States Tariff Commission, shows that during the year 1926 the domestic dye and organic chemical industry made notable progress in the United States. Developments from year to year since 1917 in the manufacture of dyes and other finished coal tar products are described as unparalleled in the history of the American chemical industry. During 1926 domestic dyes supplied 93 per cent. of the "apparent" consumption, and there was, in addition, an exportable surplus of nearly 26,000,000 lb., as compared with 1913, when 13 per cent. of the dyes consumed were produced in the United States, chiefly from imported intermediates. A significant feature of the year is that many of the new dyes are of purely American development, as contrasted with the development in former years of types previously made in Europe.

Progress in Vat Dyes

IN 1926 there was notable progress in the manufacture of fast and speciality dyes, including those for dyeing rayon and mixed fabrics. The production of vat dyes established a new record in 1926, with a total of over 4,000,000 lb., as compared with 2,600,000 lb. in 1925. None of these dyes was made in the United States prior to the war. The increase in domestic production is of interest to every consumer of fabrics as a matter of economy. Many domestic textile manufacturers have in recent years put on the market a variety of fast dyed fabrics of cotton and of linen marked with a trade name bearing a guarantee as to their fastness to washing and light. It is probable that coloured textiles will soon be marked according to their fastness. A large variety of products or commodities are now graded and sold according to definite standards, and it is logical that the same policy should be adopted by the textile industry.

Standard Tests for Fastness

THE Commission on "Fastness" of the German Chemists' Association have put forward as a standard method of testing the washing fastness of dyestuffs, the following results, as mentioned by "Spinner und Weber," Leipzig:—

(a) A sample, plaited with the same quantity of white boiled-out cotton is treated in a bath fifty times the quantity for half an hour at 40° C. with 2 gm. Marseilles soap per litre of water, then pressed out ten times in hand bales with the fingers in such a way that the plait is dipped each time in the bath, taken out, and squeezed. Finally the sample is rinsed in cold water and dried.

(b) Boil with 5 gm. Marseilles soap and 3 gm. calc. soda per litre of water for half an hour, leave to cool half an hour to 40° C. and treat ten times in the same manner as (a).

RESULTS OF (a) TREATMENT.

- (1) Colour only slightly lighter, white cotton tinted.
- (2) Colour unchanged, white cotton not or very slightly tinted.

RESULTS OF (b) TREATMENT.

- (3) Colour considerably lighter, white cotton only slightly tinted.
- (4) Colour unchanged, white cotton only slightly tinted.
- (5) Colour unchanged, white cotton not or only slightly tinted.

TYPES.

- (1) 3 per cent. Benzopurpurine 4B dyed one hour boiling with 20 gm. Glauber's salt per litre.
- (2) 5 per cent. Primuline dyed, diazotised and developed with β -Naphthol.
- (3) 2.5 per cent. Indoinblue BB on yarn premordanted with 6 per cent. tannin and 3 per cent. antimony salt.
- (4) 12 per cent. Immedialindon R. conc. or indigo dyestuff of equal depth.
- (5) Alizarine Red (aged).

Russian Production of Dyes

THE entire production of dyes and colours in Russia is now centred in the Aniline Trust. During the last few years (states the Russian journal, *Narodnoje Chozjajstvo*), this trust has rebuilt and modernised its plant at Derbenowsk, so that it is now able to produce about 2,500 tons of azo-dyes per year, thus filling almost all the requirements of the textile industry, which have been estimated at 2,850 tons. The plant is now producing 55 different azo-dyes. The total Russian demand of azo-dyes inclusive of the textile industry is estimated at about 3,300 tons per year.

Previous to the war, practically all the intermediate products required for the production of dyes were imported. To-day, a large number of these materials, such as aniline, paratoluidine, metaphenylenediamine, meta-toluylenediamine, alphanaphthylamine, phenol, salicylic acid, betanaphthol, benzidine, etc., are produced within Russia, whilst the production of other intermediate products is planned for the immediate future. Some of these are: H-acid, betanaphthylamine, gamma-acid, I-acid, etc. Hitherto, about 25-30 per cent. of the intermediate products required could be produced in Russia, but this percentage will be considerably increased by the manufacture of the new products.

There is a considerable activity in the production of sulphur dyes. The intermediate products required for the production of sulphur dyes, if not produced in Russia already, will, it is thought, be manufactured in Russian plants in the near future. Some of these materials now produced are: Orthotoluidine, paratoluidine, phenol, alphanaphthylamine, benzidine, dinitrochlorbenzene, etc.. Dinitrochlorbenzene is produced by the Southern Chemical Trust, which has been able to increase its production sufficiently to supply the entire home consumption, besides exporting a small excess.

Some progress (states the Russian journal) has also been made by the Russian dyestuff industry in the production of indophenol dyes. Blue sulphur dyes are manufactured at Leningrad and Moscow, green sulphur dyes at Moscow.

Fastness from the Maker's Point of View

By R. S. Horsfall, M.Sc.

The problem of colour fastness, which of late has been attracting so much attention, was dealt with from the maker's point of view in a recent paper by Mr. R. S. Horsfall, M.Sc., chief colourist to the British Dyestuffs Corporation, which is reproduced in substance below from the current issue of the "Journal of the Textile Institute."

I AM not quite sure that the question of fastness is one in which dyestuff manufacturers can play a leading part. The difficulty is that manufacturers are not in actual contact with the general public, which is the ultimate consumer of their wares, and in general are dependent upon the dyestuff consumer, who may have misinterpreted the demand received from manufacturers and distributors, who again may have misinterpreted the demand of the general public. While, generally speaking, the message from the ultimate consumer reaches us correctly, yet there are sufficient instances of the other kind to cause us to realise how far away we really are. The fastness of the colours used in textiles is proving a problem to everybody concerned, and something has got to be done about it. I must confine myself to the point of view of the dyestuff manufacturer.

Taking a superficial view, it would not appear that the question of fastness is of fundamental importance to the dyestuff maker, inasmuch as, like every other manufacturer, if at any given period, the quality, range, and price of his manufactures meet the market demand to such an extent that his plant is fully occupied, then he may be described as successful. His market, however, is limited to the dyer and printer, and if the latter demand dyestuffs which possess no particular fastness, obviously he must make these or go out of business. Like every other manufacturer, he must be prepared for a change in demand, and it is in the preparation for a change in demand that the question of fastness becomes of very great importance to him. Unfortunately for him he cannot make new dyestuffs to a fastness specification; blood brothers in dyestuffs show similar differences in stability to those which are exhibited by blood brothers in humans, but far more fundamental than that are the facts that organic chemistry is relatively new, and the rules of the game are very complex and so imperfectly understood that even at the moment the leading chemists of the world do not agree among themselves on the explanation of relatively simple matters of chemical combination. Under such circumstances the dyestuff manufacturer attempts to gain the time needed to meet a change in demand by foreseeing the change, and setting his research staff in motion long before the demand actually materialises.

Difficulty of Introducing Vat Dyestuffs

There have been cases, of course, where the dyestuff manufacturer has made his discoveries before his market was ripe for them, but their introduction is very uphill work, and if radical changes, both as regards technique of application and ideas of cost, are involved, then only a very wealthy concern can afford to see such introduction through. I have in mind the fast vat dyestuffs, the introduction of which absorbed my energies on first joining the dyestuff industry. The first members to be placed on the market were few in number, very limited in range of hue, very expensive both as dyeing materials and in their method of application, a convenient reducing agent had to be found, and there appeared to be every reason why nobody should be interested. The first real business was only obtained after some years; a large American firm marketing its own manufactured materials adopted one of the blues as a sky blue in place of a pale shade of indigo in gingham and shirtings, and was followed very quickly by its competitors. Later, an English manufacturer introduced his guaranteed fadeless curtain materials and caused thereby some consternation among his competitors both here and abroad. There were, of course, others who interested themselves, but the two cases will suffice as illustrations of the type of man who had to be found some twenty odd years ago. I remember that we literally hawked Indanthrene Black a year or two before finding anybody to take it up. And that I am here at this late date talking on the fastness of dyestuffs is, to my mind, ample evidence of the fact that fast colours are not even yet fully introduced in spite of the

twenty-six years which have elapsed since the discovery of the first member of the large range of fast vat colours available to-day. I might say that there are at the moment some 300 vat colours on the market.

So much for the difficulties which beset a dyestuff manufacturer ahead of his market; but what about the position to-day? Do dyestuff manufacturers believe that the public want fast colours? Of course they do, and all over the world the more progressive are spending large amounts of money, time, and energy in research, not only on the discovery of new dyestuffs, but also on new and cheaper routes in manufacture, and simpler and cheaper methods of application of the older ones. Similarly they are altering and extending expensive plant to meet the ever increasing demand for those they now manufacture. I can tell you that our sales of fast colours have shown a continuous increase throughout the bad times through which the cotton trade has been passing. The consumption of vat colours in Great Britain to-day is from three to four times that of 1914. Other classes of fast colours, such as the Azoic class, are finding a ready sale; all the evidence seems to point the one way—namely, to faster dyestuffs. I remember that when a youth one had only to hear a woman dismiss some article of clothing with the remark, "It's only cotton," to realise that cotton was the poor man's fibre. To-day we gladly pay a guinea for a cotton shirt—no poor man's fibre about that price—and the chief difference between the two periods is the introduction of the fast colours.

Fast Dyes for Wool

Wool used to be in a much better position, inasmuch as from the time of natural dyestuffs onward there has always been available a number of wool colours of very good fastness. The fashions of the last few years, however, have called for pale shades, and these have proved a little too much for the fastness to light of many old favourites, and to-day it is no uncommon thing to hear the wool man inquiring for a way by which these fast cotton colours he has heard about can be applied to wool. In a relatively small way as yet they are being applied to wool. Can anyone have the slightest doubt that the demand for fastness is a permanent one and will have to be met?

Are there any dyestuffs which are permanently fast? Do you consider that there are available to-day fast dyestuffs comprehensive enough in their range of hue to meet the demand? Do you think it possible to dye the increasingly popular mixtures of cotton, and one or other, or both, of the artificial silks in all conceivable hues so that the fastness will meet the demand? The answer to all of these must be "No." My answer seems to beg the question, "Well, what can the dyers, manufacturers, and distributors do to meet the demand until they have the necessary dyestuffs? And that I will attempt to answer shortly by advising dyers and printers to increase the use of those available at an even greater rate than the present, and everything within reason they ask for will be forthcoming. The dyestuff manufacturers have no doubt about that, but while they do not object to the casting of a good proportion of their bread upon the waters by way of research, yet they can only get the bread to cast by means of profits on present day manufacture. In other words, the fast colours must pay their way. Research is costly, but now that the textile industries have research associations and, therefore, experience of the price to be paid, it is not necessary for me to enlarge upon that feature. I would like to say, however, that the British dyestuff manufacturer has spent and is spending considerable amounts of time and money in attempting to manufacture a variety of similar dyestuffs intended for the same job. These were placed on the market during the pre-war days of intense competition by the many dyestuff concerns which now form the I.G. In those days if one firm discovered and patented a promising new dyestuff, the others, prevented by the patent from manufacturing it, immediately

set to work to find a way of making the most similar thing without infringing the patent. The original and all the imitations are still on the market, and each finds favour with one or another dyestuff user. To a dyestuff manufacturer the position appears absurd and out of date, but an even greater absurdity is the difficulty which a dyestuff manufacturer has in replacing an older dyestuff with an improved dye, even when both are of his own manufacture. I am sure a 1907 Rolls-Royce would make no appeal to a dyestuff consumer, but he has no hesitation in continuing the existence of an 1890 model dyestuff. If it were possible to get him to think of dyestuffs as he thinks of cars, greater progress could be made.

One has noted that the manufacturers and users of such things as motor tyres and steel work of all kinds have got together and cut down the number of individual sizes to a mere fraction without any serious inconvenience to anybody, and with the achievement of a considerable saving in costs. Similarly one of the larger associations of colour users has standardised the products which are used by its many branches, and has thereby achieved many advantages, not the least of which are the favourable prices which large contracts and steady demand enable them to obtain in the relatively small range of dyestuffs they buy. I think that a good case could be made out for standardisation of dyestuffs for specific purposes by the consumers as a whole.

I am not going to enter into the well-aided argument on the expense of the fast colours, and how much or how little the price of dyestuffs affects the selling price of the woven material beyond remarking that the repurchase of a bit of my fast colour after it had passed through the hands of the user, manufacturer, and distributor, and reached me again in my private capacity of a consumer of shirts and curtains, led me to some rather interesting conclusions. The first conclusion was that the science of chemistry undoubtedly does pay; the second, that, like Justice, the science of chemistry must be blind, or how otherwise can one explain the fact that she pays the wrong fellow. Fast colours are, however, expensive, but as in the case of research, similarly in the manufacture of colours already on the market, great savings could be effected if the colour users standardise their requirements.

The Matter of Guarantee

I suppose I must mention the matter of guarantee, although it is somewhat outside my sphere. What it means in terms of fastness I do not know. That it is grossly abused by some manufacturers I know from costly experience, inasmuch as in a certain case of one of the best Manchester shops it has merely meant a replacement of not fast material by a further quantity of similar not fast and equally useless material. I also know of at least one manufacturer who has made a practice of unlimited guarantees for twenty years with great success. But surely it is, at most, a passing phase in the readjustment of colour values in terms of fastness, and one which should not be allowed to prevent us from seeing the much greater forces which are at work.

It has been said to me that an exhibit at one of the popular exhibitions showing cotton fabrics immersed in boiling soap solutions, while intended to convey the idea of the extraordinary fastness of the colours used, merely had the effect of suggesting to the visitors the idea that this was a recognised method of washing coloured articles. This may be so, but why don't the distributors of coloured materials tell the people how to wash them? The soap firms are doing it, as are also the artificial silk firms, so why not those interested in colours?

If the fastness to light attainable under the most drastic conditions is only a matter of a summer season, why not say so and have done with it? My personal belief is that the average person has enough common-sense not to expect the impossible, but at the moment is somewhat at a loss, inasmuch as he or she can get the same assurance of fastness—the same guarantee if you like—for two similar articles but at two very different prices in two different shops. Naturally, the cheaper material is bought; in spite of the assurance or guarantee, it proves to have no fastness, and the only satisfaction to be obtained is replacement with the same stuff. The German dyestuff manufacturers have attempted to tackle the problem by the institution in the larger German cities of stores which sell nothing but material dyed or printed with the fast colours which they manufacture. It seems an unnecessary and drastic move, but as a dyestuff manufacturer I can quite understand

the temptation to remove the various impediments which prevent supply meeting demand. I must say at once that no similar action is contemplated by the British Corporation, whom I have the honour to represent, but one notes the action and the reports that it is proving a success.

Some New Principles in Chemo-Therapy

A New Method of Using Dyes

A JOINT meeting of the Manchester sections of the Society of Dyers and Colourists, the Society of Chemical Industry, the Institute of Chemistry, and the Manchester Literary and Philosophical Society was held on Friday, November 4, Dr. H. Levinstein.

An address entitled "Some New Principles in Chemo-Therapy," by Professor A. G. Green, F.R.S., and Dr. Coplans, was read by Professor Green. The authors stated that the chemo-therapy of dyestuffs and allied synthetic organic substances, based largely upon the views of Ehrlich, had on the whole been disappointing, owing to the influence of factors not at first realised—namely, the chemical alteration of the drug under the influence of living matter. Such progress as had been made in therapeutic research had been mainly empirical. The authors had examined the question whether it might not be possible to exert a controlled and selective action upon foreign organisms and their toxins by the administration of compounds (derivatives of dyestuffs in particular) which were themselves inactive and innocuous, but which could be converted in the body or particular parts of it into active agents. The slow and continuous production within the system of such an active substance might exert a definite bactericidal or at least bacteriostatic action without materially harming the defensive cells.

Two classes of compounds which might fulfil these conditions had been examined:—(1) Leuco compounds which could give rise to physiologically active dyestuffs upon oxidation; and (2) special dyestuffs (or leuco-dyes) containing "labile-acidic" groups, such as the "sulphato" group, $\text{NH.C}_6\text{H}_4.\text{OSO}_3\text{H}$, or the omega-sulphonic group, $\text{NH.CH}_2.\text{SO}_3\text{H}$. These new classes of dyestuffs had been described in a series of papers by Green and Saunders published during 1922 and 1923. While functioning in the unaltered condition like ordinary acidic dyestuffs (or leuco-dyes), they were converted by hydrolysis into basic compounds.

From the authors' investigations the following conclusions were derived.

1.—Leuco dyes of the triphenylmethane class had a much smaller toxicity and bactericidal activity than the corresponding dyestuffs. When administered to animals they were excreted both by the liver and kidney if acidic or by the liver alone if basic.

2.—Leuco dyes of the triphenylmethane class exhibited a very remarkable neutralising or detoxicating action upon toxins such as those of diphtheria, tetanus, and cobra venom. In the case of the first two a very definite quantitative relationship could be proved to exist which varied with the toxin and the leuco-dye. It was believed that further investigation of this action might afford a basis for the local treatment of diphtheria, tetanus, and snake bite.

3.—Sulphato dyes and sulphato leuco-dyes had in the unaltered condition but little toxic action and little or no bactericidal power. When, however, those substances were administered to animals they were excreted both by the kidneys and liver, and rendered the urine and bile strongly antiseptic.

4.—Rabbits which had been artificially infected with an active strain of *B. typhosus* and had thus become "typhoid carriers" were completely sterilised by continued administration of sulphato compounds.

5.—Experiments made with mice infected with *trypanosomum equiperdum* indicated the possibility of employing omega-sulphonic acids of active substances for blood sterilisation.

The results obtained would seem to indicate the possibility of new methods of attack in the treatment of disease, in which substances having little or no toxicity or physiological activity in themselves might be administered with the object of gradually liberating in the system by chemical changes definite active drugs having a destructive effect upon invading organisms.

Basic Intermediates for Dyestuffs: No. XII.—Benzaldehyde and Its Derivatives

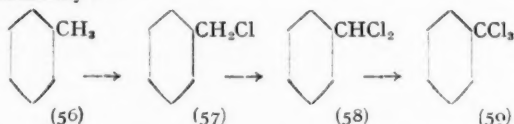
By "Consultant"

THE value of benzaldehyde as a dyestuff intermediate is always more real than apparent, since it is mainly through its simple derivatives that it finds actual use, in spite of the utilisation of a small proportion of the output for such colours as the various greens (*e.g.*, Malachite, Light Green SF, Guinea, and Brilliant) and certain of the acridine and flavine shades. As might be expected from the generally difficult nature of aldehydes, when handled on a large scale, benzaldehyde is not easily produced in good yield from the basic raw material, toluene, and considerable ingenuity has been applied to devising improvements in its production from this source.

The first stage in the preparation is, of course, obtaining a fairly pure toluene, but since this is merely a matter for efficient fractionation it may be passed over with no further comment than that a fairly good quality toluene is not only desirable but essential to the success of the preparation. Earlier processes involved the chlorination of the methyl side chain of toluene and the subsequent hydrolysis of the chlorination products to a mixture which contained a certain amount of benzaldehyde, and much of the aldehyde is still made on these lines; more modern processes, however, oxidise the side chain straightway to the aldehyde group, and so avoid the intermediate troublesome chlorination. The disadvantages of the direct oxidation processes invariably include the fact that if the oxidation is allowed to proceed, so that a large proportion of the toluene treated is oxidised, part of it is destroyed, or converted to useless products; whereas, if the oxidation is so conducted that little or no destruction takes place there is always a large amount of unchanged toluene at the end of the reaction.

The Chlorination

The various products which can be produced from toluene by chlorination are so numerous and difficult to separate that the physical conditions of the chlorination—temperature, illumination, catalyst, etc.—must be regulated within very narrow limits if a large yield of any one product is to be obtained. It is a time-honoured text-book statement that when toluene is chlorinated in the dark, with iron as a catalyst, ortho- and para-chlorotoluenes are produced; and that if illumination and phosphorus trichloride be used, then benzyl chloride, benzal chloride, and benzotrichloride are produced successively:—



Actually the process is complicated by the fact that a certain amount of nuclear substitution always takes place, whilst, in addition, the three compounds just mentioned are produced simultaneously, and it is not possible to stop the chlorination at, say, benzal chloride. Irradiation with the light from low-pressure mercury vapour lamps (high-pressure lamps favour the formation of benzotrichloride) is often employed in conjunction with a catalyst, such as phosphorus or antimony trichloride, in order to obtain an increased yield of benzal chloride, which is alone of use in the preparation of benzaldehyde by simple hydrolysis, and some patented processes claim that either of the three chloro compounds can be obtained at will by suitable irradiation of mixtures of toluene vapour and chlorine. Although this claim has scarcely been substantiated on large scale plant, there is no doubt that by conducting the chlorination in the vapour phase, larger yields of the desired chloro compounds may be obtained.

In the older processes the toluene was chlorinated in the liquid phase and the benzyl chloride separated from the benzal chloride and benzotrichloride by fractionation, a mixture of the two latter compounds being hydrolysed direct. Nowadays it is more profitable to work for benzyl chloride and to treat this with an oxidising as well as a hydrolytic agent. It is in this direction that the ultra-violet irradiation in the vapour phase is most helpful. The figures below illustrate

the effect of the irradiation of toluene vapour and chlorine, the former in excess:—

	Fraction	With Ultra-violet	Without Ultra-violet
1.	To 150° C.	72	42
2.	150–170° C.	4.2	2
3.	170–185° C.	18.5	47.5
4.	185–315° C.	3.8	6.5

From these figures it is evident that a satisfactory yield of benzyl chloride may be obtained. The diagram (Fig. 1) shows the type of apparatus that is used for the irradiation—

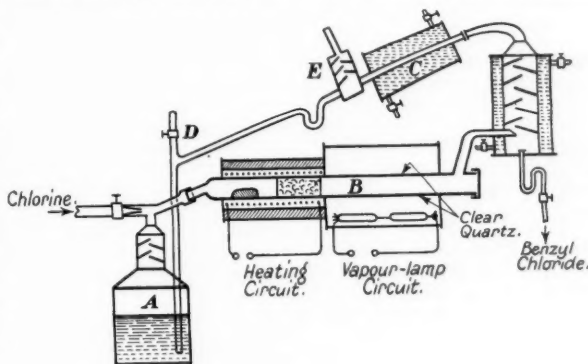
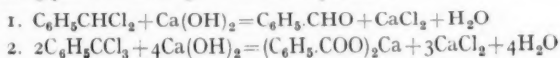


FIG. 1.

chlorination process. Toluene in the vessel A is boiled by a current of hot oil through the heating coil, and the vapour mixed with chlorine is passed through the tube B, which is heated, and in which the mixed vapours pick up a small amount of phosphorus pentachloride. The latter half of the tube B is made of clear quartz and is irradiated with light from low-pressure mercury vapour lamps. The issuing vapours are passed through a dephlegmator maintained at about 150° C., where benzyl chloride condenses and leaves the system. The condenser C serves to condense the toluene, which is returned to the vessel A. More toluene may be added via the cock D, and hydrogen chloride is allowed to leave the system through the valve E. Needless to say, a battery of such chlorinators is established with a common plant for rectification of the crude benzyl chloride which leaves the system.

Hydrolysis to the Aldehyde

In the older methods the mixture of benzal chloride and benzotrichloride obtained by chlorination was heated with milk of lime under a pressure of five atmospheres, hydrolysis taking place according to the two equations:—

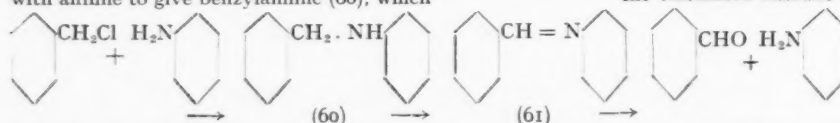


The benzaldehyde was removed by steam, and benzoic acid was obtained from the calcium salt remaining after steam distillation. The yield is not good, for even under the conditions specified there is always a certain proportion of the chloro compounds which escapes decomposition, whilst in addition, part of the benzaldehyde is destroyed by oxidation to benzoic acid. The process was improved by the invention of Espenscheid, who found that the addition of barium sulphate in fine powder had the effect of emulsifying the benzal chloride, and allowing the reaction to take place at 100° C. at ordinary pressure. Considerable modifications in the process resulted from the researches of Schultz, who introduced water in the presence of catalytic quantities of metallic iron as the hydrolytic agent. His process is often used where the benzal chloride-benzotrichloride mixture is to be worked up. The mixture (1 cwt.) is heated by indirect steam to 25–30° C., and a few ounces of powdered iron ("pin-

dust") are added together with water (1 cwt.). The reaction takes place with indirect steam heating or water cooling, as may be necessary. Much hydrogen chloride is evolved, and the temperature is maintained at about 90–95° C. The residual liquor is made alkaline with screened hydrate of lime (22 lb.), and the benzaldehyde distilled over with steam. The crude benzaldehyde which is obtained in this manner, and the density of which is about 1.05, is purified almost invariably through the bisulphite compound, which, however, need not be isolated for this purpose. The crude aldehyde (1 cwt.) is run into sodium bisulphite liquor (5 cwt., 25–30° Bé.). Stirring is used to effect solution, and the mixture is heated to 40° C., allowed to settle, and the clear solution decanted into milk of lime, after which the benzaldehyde may be steamed out. The yield from the above quantities is about 100 lb. of benzaldehyde and 40 lb. of benzoic acid.

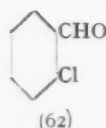
Numerous processes have been proposed for oxidising toluene straightway to benzaldehyde, and a certain amount of commercial benzaldehyde is manufactured in this way. The best reagent is said to be chromyl chloride, but no details of commercial applications of this process are known to the author. Probably the cheapest method of toluene oxidation is that with manganese dioxide and sulphuric acid. Toluene (3 cwt.) is added with stirring to 65 per cent. sulphuric acid (7 cwt.), and manganese dioxide (1 cwt.) is added slowly, with vigorous stirring. The finely-divided oxide obtained by recovery from a previous batch is to be preferred, since oxidation proceeds more smoothly and readily with it than with the ground pyrolusite with which it is necessary to start operations. The temperature is kept at 40° C. during the oxidation, and after the operation is finished the benzaldehyde and excess of toluene is steamed off. About 2½ cwt. of toluene and 1 cwt. of benzaldehyde are recovered. It is necessary to separate the aldehyde from the toluene by a sulphite process.

The utilisation of benzyl chloride from the irradiation method of chlorination can be accomplished in several ways. Perhaps the simplest is to heat it under pressure with a solution of lead nitrate in water, but several undesirable by-products are obtained in this way. One method of some interest is that in which the benzyl chloride is condensed with aniline to give benzyaniline (60), which



is then oxidised to benzaldehyde (61), by the addition of sodium dichromate solution in 20 per cent. sulphuric acid to its solution in boiling water. The benzyaniline is decomposed by mineral acid, and the benzaldehyde steamed out in the usual way. If hexamethylene-tetramine is used in place of aniline the whole process may be shortened and the use of an additional oxidising agent avoided. In this process the hexamethylenetetramine (30 lb.) is boiled in 60 per cent. alcohol (80 gall.) with the benzyl chloride (25 lb.) for a period of five hours, after which water (40 gall.) is added, the alcohol distilled off, and the benzaldehyde removed by steam distillation.

Patents have been taken out protecting the use of various other processes for the production of benzaldehyde. Those of the Bayer Co. are, perhaps, the most interesting, since they cover the processes involving the Gattermann-Koch reaction. Two main processes are cited, the passage of a mixture of carbon monoxide and hydrogen chloride into benzene in the presence of anhydrous aluminium chloride and cuprous chloride as catalysts, and the passage of hydrogen cyanide and hydrogen chloride into benzene containing aluminium chloride in suspension. There are distinct possibilities in both these processes provided that the mechanical difficulties can be overcome.



The Derivatives of Benzaldehyde

o-Chlorobenzaldehyde (62), which finds a limited use in the production of Night Green A and the Setocyanines, is obtained from the chlorination products of *o*-nitrotoluene. When this substance is chlorinated at 120–140° C. until about half the theoretical amount of chlorine has been absorbed, a mixture having the following

percentage composition is obtained: *o*-nitro-benzyl chloride, 20; *o*-chlorobenzyl chloride, 20; nitro-toluene, 60. The separation of this mixture offers an interesting problem, which has been solved by the preliminary conversion of the chlorides to the corresponding alcohols. The crude mixture (10 cwt.) is boiled with dilute alcohol (160 gall.), sodium carbonate (1½ cwt.), and sodium acetate crystals (5 cwt.). The boiling converts the two chlorides into the corresponding derivatives of benzyl alcohol, leaving the nitro-toluene unchanged. The latter is distilled off in steam, and the residual liquor diluted with just so much water as will keep all the salts in solution on cooling. The alcohols—*o*-nitrobenzyl alcohol and *o*-chlorobenzyl alcohol—remain as a soft insoluble mass on cooling, and are filtered off and pressed. They are oxidised without separation to the aldehydes. The press cake (2 cwt.) is rapidly stirred with sulphuric acid (50–60° Bé., 7–7½ cwt.), and a mixture of sulphuric acid and nitric acid (1 cwt., containing 40 per cent. of HNO₃) is added slowly, the temperature being kept at 40° C. Oxidation takes place at a steady rate with the evolution of nitrous fumes, and when the process is complete the mixture is run into water (100 gall.), and the aldehydes separated from the acid liquor. The mixture obtained consists of:

An oil—*o*-chlorobenzaldehyde, m.p. –4° C., b.p. 212° C.

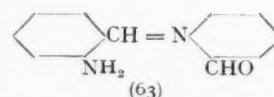
A solid—*o*-nitrobenzaldehyde, m.p. 46° C.

For dyestuffs purposes they are separated by pressing, the oil coming through the press being sufficiently pure *o*-chlorobenzaldehyde for dyestuffs manufacture.

Nitro and Amino-benzaldehydes

The direct nitration of benzaldehyde proceeds in a curious way, the nitrobenzaldehyde produced consisting of 80 per cent. of the meta derivatives and 20 per cent. of the ortho isomer when the temperature is kept at 30–35° C. More ortho, and some of the para isomer are obtained if the temperature is allowed to rise above this point, together with a considerable amount of oxidation to nitrobenzoic acids, but if the nitration is performed at a temperature below 5° C. a 90 per cent. yield of the meta derivative may be obtained. The best nitrating mixture appears to be a solution of rather more than the calculated amount of sodium nitrate in concentrated sulphuric acid, to which the benzaldehyde is added slowly and with continual stirring. The mixture after nitration is poured into water and the semi-solid matter which separates is removed, the ortho isomer being separated from the meta by centrifuging and pressing.

The preparation of *m*-hydroxybenzaldehyde from *m*-nitrobenzaldehyde involves its preliminary conversion to the amino compound. The method used depends on the nature of the raw material. If the nitration is conducted to obtain technically pure *m*-nitrobenzaldehyde, this is often reduced with ferrous sulphate, but the crude mixture of ortho and meta isomers may be reduced together and the separation of the isomeric amino compounds effected in the following way. The crude mixture containing 20 per cent. of ortho nitrobenzaldehyde is stirred with five times its weight of water and the calculated amount of sodium hydrosulphite to reduce the nitro groups to the amino condition. The solution is raised to the boiling point; after ten minutes it is cooled to 50° C. and enough hydrochloric acid added to neutralise all bases present. Sulphur dioxide is removed by boiling, and on cooling the anhydro



base of *o*-aminobenzaldehyde (63) separates out and may be filtered off from the solution of *m*-aminobenzaldehyde, which is usually used direct. To the solution is added 2½ molecular proportions of hydrochloric acid, and the mixture is cooled to 0° C. and treated with the theoretical amount of sodium nitrite. Live steam is led in until no more nitrogen is evolved, after which the whole is concentrated and extracted with benzene. The *m*-hydroxybenzaldehyde is obtained as a white crystalline mass, m.p. 107° C., b.p. 240° C.

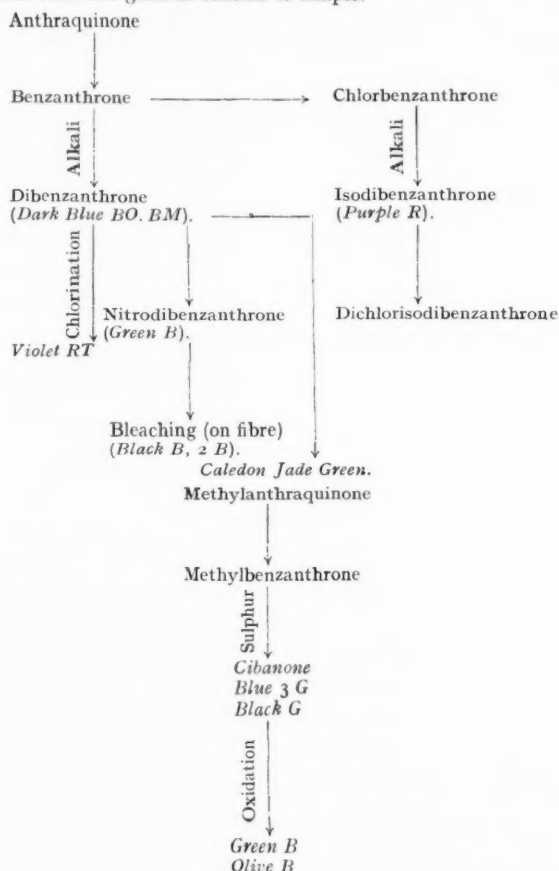
Dyes and Their Application: Recent Technical Progress

By L. J. Hooley

Benzanthrone Derivatives

As some of the most important vat colours are benzanthrone compounds, and knowledge of the chemistry of these has been greatly extended in the last five or six years, it will be of interest to consider some of the principal developments. As a basis for this, the salient features of these derivatives may be mentioned so as to serve as a basis of comparison.

The methods which have been used for manufacturing the principal benzanthrone colours can be seen from the following diagram, where in the cases of colours sold under several names, the essential part of the name only is given and Indanthrene, Caledon, Duranthrene, Paradone, Alizanthrene, Anthrene, Anthrone, etc., must be understood. It will be seen that the general scheme is simple.

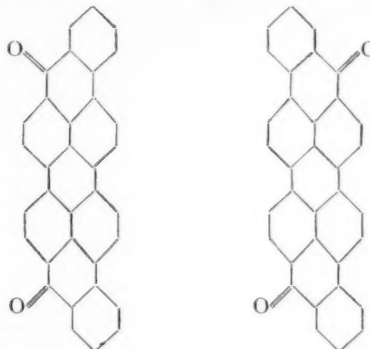


Recent new work divides itself roughly into improved methods of manufacture and slightly modified forms of old dyestuffs, which can be superimposed on the above scheme, and fundamentally different methods of synthesis which cannot. This latter subdivides itself into syntheses starting from anthracene and benzanthrone and those starting from naphthalene. While the first are of most immediate importance, the others have yet to be fully exploited. In addition, as a result of these researches on benzanthrone a large number of other derivatives of analogous types have been obtained, which come under other headings and are comprised under the general title of polycyclic compounds. On referring to the diagram, it will be seen that the colours are all at the blue end of the spectrum, the lightest being Brilliant Purple RR. In the recently discovered pyrene-quinones, which can be obtained from benzanthrone, yellow and orange shades are, however, to be found, and taking the polycyclic series as a whole, shades of all kinds are included. The new methods which are most closely allied to the old will be dealt with first.

Blacks from Dibenzanthrone

Dibenzanthrone itself is a dark, rather reddish-blue; on nitration it gives, as might be expected, a product of very similar colour. On dyeing in the vat this is reduced to aminodibenzanthrone, which has a full green shade. The nitro body can of course be reduced before dyeing, the result being the same. With oxidising substances, especially bleaching agents, this green shade is converted to a black; the mechanism of the change is not certain, but it is generally assumed to be connected with the amino group, and possibly there is a linking up between two of these. The conversion of the green to black has to be done on the dyed material, as the black would be reconverted to green in the dye vat. This black is unequalled for fastness; it is used especially for effects such as black stripes in white shirting material, where the highest fastness to laundering is necessary, and where it is essential that there shall be no "marking off" on to the white. Very often the black is woven into the white in the unbleached or grey condition and the bleaching of the cloth also serves to develop the black.

Considering the very close similarity between isodibenzanthrone and dibenzanthrone, it might be expected that a black



could also be obtained from isodibenzanthrone by nitration. This is in fact the case, but the black is much inferior to nitrodibenzanthrone in properties, and besides this isodibenzanthrone is a more expensive starting point.

As this black from nitrodibenzanthrone requires a bleaching treatment, attempts have been made to obtain a dyestuff which would not need this, and several such blacks have been brought out. These are known as direct blacks, but are of course not to be confused with the ordinary direct substantive colours.

Among these, in addition to others which have already been described in THE CHEMICAL AGE, there are the following:

In B.P. 264,502 (I.G.F.A.) aminodibenzanthrone is treated with methyl esters of sulphuric acid, but the usual acid absorbing agent is not added. The products thus obtained may be used for blacks or greys.

In B.P. 254,742 (I.G.F.A.), by fusing an aminochlorbenzanthrone, a product is obtained which dyes directly in reddish-grey to black tints.

In G.P. 430,704 (I.G.F.A.) dibenzanthrone is treated with substances which give sulphur, in the presence of copper, antimony, or phosphorus compounds. This is an extension of a previous patent in which the process was used with nitrodibenzanthrone.

L. B. Holliday and Shaw oxidise dibenzanthrone with sulphuric acid and a dichromate or with nitric acid or manganese dioxide and sulphuric acid (B.P. 277,125).

Benzanthrone Sulphonic Acids

In a series of three recent patents, the B.D.C. prepare black and grey dyestuffs, starting from benzanthrone sulphonic acids, other products being obtained at the same time (B.P. 276,766-7-8, B.D.C., Baddiley, Shepherdson, and Thornley).

They sulphonate either in monohydrate at 180-190° C. or with 30 per cent. oleum at 90° C. These sulphonic acids when fused with alkali give reddish-blue vat dyestuffs, somewhat

similar to dibenzanthrone. The dye obtained by the alkali fusion is slightly sensitive to acid and may be converted to a faster product of deeper shade by alkylating. By condensing the reddish blue colour from the alkali fusion of benzanthrone sulphonic acid with hydroxylamine, black and grey vats are obtained.

Halogenated Derivatives

The great advantage of the benzanthrone colours is that they have an even balance of fastness, and are not spoiled by individual weaknesses as are some otherwise excellent colours. The fastest is, of course, Caledon Jade Green. Isodibenzanthrone is itself greatly improved by chlorination, and although the unchlorinated product is in actual use, it does not show the same brightness. Dibenzanthrone is also halogenated but does not have quite the same importance in this respect. Among new methods of halogenation the following are of interest:

B.P. 253,163 (Brit. Aliz. Co., Anderson and Dawson). Dibenzanthrone or isodibenzanthrone are chlorinated in fine suspension with, for example, potassium chlorate and hydrochloric acid in the cold; thus dibenzanthrone is dissolved with sulphuric acid and then poured on to ice, and sodium chlorate and hydrochloric acid are added to the suspension, which is kept in the cold for four hours.

The following are some of the new colours of this series which have been placed on the market within the last year or two: Alizanthrene Brilliant Violet BR, which dyes in redder shades than Dark Blue BO; Paradone Violet BR gives somewhat similar shades. Caledon Navy Blue gives full dark blue shades without the reddish tinge of Caledon Dark Blue BM. Caledon Jade Green G is yellower in shade than Caledon Jade Green. There are also Anthrone Black and Dark Blue B and several Paradone Blacks.

Dyestuffs Markets: The Month's Business in Review

From Our Own Correspondents

Lancashire

There is little of interest to report concerning dyestuff movements in October. On the whole the volume of business passing changed little, but the tone of the market generally grew less optimistic as the month progressed.

The position of the cotton industry remains very unsatisfactory, and at the moment there seems to be no prospect of early change. It is with regret that one notes the breakdown of the negotiations between the Cotton Yarn Association and the Federation of Master Cotton Spinners, which cannot but make the situation more difficult. It is to be desired that some method of organising the cotton trade will be devised, as otherwise the old process of survival of the fittest with all its attendant disasters is bound to take place.

During the month the Nuera Art Silk Co. has been the subject of many rumours. It was largely believed that J. and P. Coats were taking an interest in its development, but that rumour is now understood to be untrue. There is, of course, nothing unlikely in such an arrangement; indeed it has been stated that J. and P. Coats are quite largely interested in the Snia Viscosa Co. Courtaulds themselves were originally, and still are, silk cr pe manufacturers, similarly Harbens was started by Mandelberg, the Bulmer Rayon Co. by Smith, Bulmer and Co., the Brysilka, Ltd., by Naylor Jennings, and while the British Cotton and Wool Dyers are interested in the Nuera, the Winterbottom Book Cloth Co. are interested in British Enka. It would thus appear clear that many textile firms are widening the basis of their operations, and it is possible that the continued difficulties in the trades connected with the older textile fibres will tend more and more to increased activity in the new artificial fibres. There has been for some time talk of changing cotton mills over to the spinning of yarns from short lengthed artificial silk filaments, and undoubtedly there are possibilities in this direction.

Rumours concerning the I.C.I. and I.G. have not been so prominent this month, although it is still believed that negotiations are proceeding. One curious feature of the rumours is that they appear, in the main, to have their source in Germany rather than in Great Britain.

Yorkshire

Better things still figure in promise only; the position generally is better than it was a year ago, but one does not feel that prosperity is imminent. The Mackenzie Award ceases to operate at the end of November, and October has been busy with announcements, meetings, notices, statements, etc., concerning the Allied Association of Bleachers, Dyers, Printers and Finishers and the Joint Dyers' Executive (the trade union organisation) and their desires and intentions as to the terms under which the industry shall be manned after that date. It augurs well that the spirit of negotiation between the parties is reasonable and friendly.

The 2-times factor has now settled down to a humdrum existence, but those in the colour-making trade are inclined to ask themselves how long the active Colour Users' Association will allow it thus to remain. There has been a further easing, of slight dimension, of the price of benzol; to some

this quiet restfulness is as the lull before the storm, for another, and early, drop in the price of petrol is sensed, and it is well known that petrol price fluctuations find a very sympathetic response in the benzol market. Benzol distillers have experienced a new demand for solvents for preparation of cellulose lacquers which were such a feature at this year's motor show, but these, notwithstanding the prices of xylenes and solvent naphthas, continue to drop.

Foreside Dyeworks, Denholme, the property of the Yeadon Dyeing Co., were sold early last month by auction, the purchasers being the Bradford Dyers' Association, Ltd., for £19,250. Bidding was started at £5,000 and advanced in thousands to £17,000 and then in hundreds to £19,000.

The Yorkshire Dyeware Co.'s factory, situated near the Aire and Calder canal at Selby, became the scene of a fire, the flames spreading to the roof of part of the premises and being subsequently extinguished by the Selby Fire Brigade. Considerable damage was done, but work was interrupted only to a small extent.

Scotland

The Exhibition of Textile Machinery held in Edinburgh in the middle of last month was a complete success. This was the first time the exhibition had been located in Scotland, and the attendance was considered very good. Some of the machinery was seen on exhibition in Scotland for the first time, and while most of the plant was in the cotton and woollen sections, of special interest in the latter being the fine knitting machines, there was also some space devoted to the artificial silk branch. Artificial silk has not been of great importance in Scotland hitherto, but now, both as regards manufacture and making-up, there are signs that interest is growing. One of the most pleasing developments in this direction is the attempt of the linen manufacturers to utilise some of their standing machinery for this purpose. Quite remarkable success has attended the trials in some cases and, several firms in the Dunfermline district have machinery running.

The brightest quarter of the Scottish industry is still the woollen trade. This is holding its level of prosperity very well. Export trade has been good and general both with Europe and farther away.

In the Glasgow and Paisley districts the general level of business is about the same as last month. Dyers and finishers are more slack than they would like to be, although busier than they were two or three months ago. As previously, there is greater activity in the yarn section than in piece goods, and the most happily placed are the wool yarn dyers.

The general feeling is that, considering the present times, trade in Scotland is not so bad. The fairly good conditions of the last two months have been maintained and slight improvements are evidenced in a few directions. There is no talk of considerable developments in the near future.

The dyestuffs market remains fairly steady, but chemicals have shown a slight improvement during the last fortnight both in the home and export sections. The erection of the new steel boiler chimney at the Scottish Dyes works is now complete and is of quite imposing proportions.

Dyestuffs Monthly Supplement

Published in the second issue of "The Chemical Age" each month

Communications relating to editorial matter for the Dyestuffs Monthly Supplement should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Advertisement matter, subscriptions, etc., should be sent to the Manager. The Supplement is devoted to the interests of both manufacturers and users of dyestuffs, and contributions will be welcomed.

Spring Shades for 1928

THE list of "fashionable shades for spring" issued by the British Dyestuffs Corporation is always interesting, and those relating to spring of 1928 have just reached us. Like those of recent seasons, they are notable for the absence of strong bold colours, and the fondness for delicate shades. The colours shown in the present list are Gazelle, Blush Rose, Mavis, Maize, Passion Flower, Chestnut, Bluette, Puritan, Atlantic, and Zulu. These, of course, are only a few suggestions, and the B.D.C. offer to give recipes for the matching of any other desired shade on wool or any other material. The dyeing of the colours is carried out, in the manner usual for acid colours, with the addition of 10 per cent. Glauber's salt and 2 per cent. sulphuric acid. It is a point of some interest in colour blending to note that these eight quite distinct tones are produced by varying in the dye bath the proportions of four colours—Lissamine Fast Yellow 2G, Lissamine Fast Red BG, Alizarine Ultra Blue B, and Alizarine Delphinol BDN.

The Importance of the Industry

THE paper by Sir Joseph Turner, published in this issue, brings out very prominently the importance of a dyestuffs industry to the nation whether in time of peace or in time of war. Further, not only is the manufacture of dyestuffs in itself a substantial industry, both in the number it employs and in its annual turnover, but its importance is immensely enlarged when one considers the number of other industries to which adequate colour supplies are essential. The figures given by Sir Joseph Turner will surprise many people who have never gone into the actual details, and in any case quite justify his final conclusions—that the maintenance of a British industry is essential and that any combination with other countries that threatened the independence of the home industry is not to be thought of.

Franco-German Cartel Reports

REPORTS and rumours of chemical trusts, cartels, and combines follow thick and fast upon one another. For some time past the United States Press has been greatly agitated about the "impending" formation of a European chemical trust. The latest note on the subject is from the Paris correspondent of *The Times*, who states (December 2) that it is reported that an agreement has been signed at Frankfurt and in Paris constituting a Franco-German "cartel" for controlling the production and prices of dyestuffs and coal tar products. The agreement, which has to be ratified by Kuhlmann's and the Interessengemeinschaft, assigns to each country the various world-markets to which it may export. Thus far the "cartel" embraces the French and German industry, but it is stated that efforts will still be made to bring England into it. Similar agreements on the production of artificial silks and nitrogenous compounds are now being negotiated.

Affinity of Soluble Vat Dyes for Cotton

IN a lecture published in the *Journal of the Society of Dyers and Colourists*, Mr. Peterhauser made the interesting statement that certain Indigosols (not yet on the market) had been found to have a direct affinity for cotton. In the

November number of the same publication, Mr. J. E. G. Harris points out in this connection "that there have been on the market since the beginning of 1925 soluble derivatives of vat dyestuffs which have such an excellent affinity for both vegetable and animal fibres that they can be dyed by ordinary dyeing processes, viz., certain of the Soledon colours (S.D.C.), which are, for the most part, sulphuric acid esters of the enolic forms of vat dyestuffs.

"Those Indigosol colours described by Mr. Peterhauser in his lecture as having no affinity for vegetable fibres are indigoid or thioindigoid in character, whereas the members of the Soledon series which possess such affinity are anthraquinonoid in origin. This absence or presence of affinity for vegetable fibres appears to be an important distinction between the two classes of sulphuric acid esters—the indigoid and the anthraquinonoid. It is true that all anthraquinonoid derivatives do not possess affinity to the same marked degree, and cases are known where the affinity is of the slightest. On the other hand, amongst the indigoids affinity appeared to be practically non-existent before Mr. Peterhauser's announcement was made."

The Australian Licensing System

MR. E. C. SQUIRE, of Sydney, Australia, the U.S.A. Trade Commissioner there, is not quite correct in his description of the Australian dyestuffs licensing system. In a report to his department he states, probably quite rightly, that the restrictions imposed upon the importation of foreign aniline dyes are objected to by a section of the New South Wales textile manufacturers and that they have lodged a complaint with the Federal Government. It is claimed that in view of the growth of large textile, tanning, and other industries that use dyes, and the necessity for meeting competition of outside manufacturers who have access to the best markets in the world, the Australian manufacturer should be permitted to purchase dyestuffs which he considers suitable for his purpose. The present position, Mr. Squire states, is that "all requests for licences for the importation of foreign dyestuffs to Australia must be referred through the Commonwealth Customs Department to the Dyestuffs Advisory Licensing Committee, a branch of the British Board of Trade in London." This is not so. The Commonwealth Customs Department in London deal with such applications under their own regulations, and there is no official connection between that department and the British Licensing Committee, though these bodies may occasionally consult each other. Those who desire free imports of dyestuffs into Australia argue that in any case trade is lost through the delay occasioned by sending to England. It is claimed by them that the authorities in London do not and cannot know the particular requirements and needs of the Australian users, which in many cases differ widely from those of the English dyestuff-using industries.

Leather Dyeing: American Methods

MR. M. C. LAMB, of the Leathersellers' College, last year paid a visit to the United States, in the course of which he was able to study American methods of dyeing and finishing leather. Describing his experiences, he said that perhaps one of the chief differences in the general procedure of leather dressing in the U.S.A. was in the direction of

mechanical application. Whilst in Britain the majority of fancy leather dressers either tray dyed or dyed in paddles, the majority of American dyers used the drum. In a well-equipped factory in America the outstanding features to a British observer were: (1) Utilisation of mechanical means for carrying out as far as possible every operation, the general lay-out of the works being such that as far as possible there was no retrograde step in the whole sequence of operations from the commencement to the finish; (2) the large bulk of goods in course of processing. As regards dyestuffs, most American manufacturers employed basic dyestuffs, whilst in Britain it was, generally speaking, the practice to use acid wool dyestuffs. Acid dyes did not accentuate the faults of skins, but basic colours had a more intensive colouring power.

Use of Pigment Dyeing for Leather

MR. LAMB then went on to describe the conditions which led to the adoption in America of pigment or mineral colours, stating that owing to the war the supply of dyes was cut off, as was the case in Britain. After a great deal of work, a method was evolved for colouring leather by the use of mineral earths, and this had a very far-reaching effect throughout the world, as practically every class of leather was now being coloured to some extent by pigments of mineral origin. It was found that a properly prepared pigment, such as was used in the colouring of paints and enamels, but made with a water medium and in conjunction with a suitable binding agent, had the effect of rendering the grain surface of leather more uniform in tone. This eliminated a good deal of the labour which was formerly expended on matching up the various pieces of leather which went into ladies' shoes and other feminine requirements.

The finishes or dopes consisted of mineral earths usually ground in a soluble oil medium to the colloidal condition, which enabled them to remain suspended for a considerable time in an aqueous solution of shellac, gums and casein, which latter were employed for the purpose of attaching the pigment more firmly to the surface of the leather. These pigments had to a certain extent now been improved upon by a better method of grinding, the inclusion of plasticisers, and by the addition, in certain cases, of coal tar pigments. As many mineral pigments were fast to light, coloured leather was to-day perhaps more uniform and faster to light than had hitherto been the case.

United States Coal Tar Imports

CONSIDERABLE efforts have been made by the United States chemical concerns to free the country from the necessity for the import of foreign dyestuffs. In this connection there is a great deal of useful information in a note which appears in our United States contemporary, *Chemicals*: "We have before us the tabulation of imports of coal tar products by countries of origin for the month of July of the present year. It is an interesting vista in that the contrast offered by 1925 and 1926 for the same month and for similar items is an illuminating one, as will be seen from a study of the data to be given herewith."

"The one major item in this list of imports—creosote oil—is still holding to the fore, and the total for July of this year is just a little ahead of that for July, 1925, although about 4,800,000 gallons less than the total for July of last year. However, Germany played no part whatsoever in this gallonage. The totals were, in gallons:—

July, 1925	July, 1926	July, 1927
6,735,919	11,612,179	6,853,385

"Again, all other coal tar crudes, in value: July, 1925, \$86,283; 1926, \$78,577; 1927, \$47,975. And \$26,671 worth was from the United Kingdom! Getting into the

group of the coal tar intermediates the first item regularly carried in the recapitulation is "coal tar acids," and this is what we find: July, 1925, 40,815 lb.; 1926, 57,435 lb.; 1927, 9,438 lb. Of this amount Germany shipped us 6,581 lb. Next comes the "all other intermediate products," and here as well is a similar slump registered: July, 1925, 328,051 lb.; 1926, 51,752 lb.; 1927, 66,869 lb. —55,536 lb. from Germany.

Finished Dyestuff Imports

"THERE is a little different story when we consider the finished products groups, but the showing is not at all an alarming one from the viewpoint of our makers of this type of commodity. First in the roster is alizarin and its derivatives: July, 1925, 1,029 lb.; 1926, none; 1927, 1,964 lb. Then comes the important grouping of 'colours, dyes, stains, etc.': July, 1925, 374,698 lb.; 1926, 181,967 lb.; 1927, 278,102 lb., with 142,890 lb. from Germany and 96,030 lb. from Switzerland. Coal tar medicinals is the next on the list with the following comparison: July, 1925, 3,911 lb.; 1926, 5,648 lb.; 1927, 3,633 lb., with 2,173 lb. from Switzerland and 772 lb. from Germany. In the 'all other coal tar products' group we find a radical change, but with France as the principal country of origin this year: July, 1925, 279 lb.; 1926, 2,772 lb.; 1927, 16,089 lb. Of this total France shipped us 11,359 lb., Germany 4,618 lb., and the United Kingdom 112 lb."

Inks, Dyes and Colours in Canada

FINAL statistics issued by the Metallurgical and Chemical Branch of the Canadian Bureau of Statistics at Ottawa, under the direction of Mr. S. J. Cook, show that production in the inks, dyes and colours industry in Canada during 1926 was valued at \$2,819,945, an increase of 3 per cent. over the total of \$2,749,807 for the previous year. Plants making inks, dyes and colours represent a capital investment in Canada of \$2,729,166. Purchased materials used during the year cost \$1,069,957, and the value added by manufacturing was given at \$1,749,988. This industry afforded employment to an average of 441 people, paid \$728,273 in salaries and wages, and expended \$38,249 for fuel and electricity. Of the 27 plants in this industry, 7 made dyes and colours, 14 made printing inks, and 6 produced writing inks as the main product.

Imports into Canada of dyeing and tanning materials of all kinds were valued at \$3,654,158 during the calendar year 1926. Imports of printing inks, mostly from United States, were valued at \$243,490; writing inks at \$41,527, of which about 50 per cent. came from the United States; and mucilage and adhesives at \$105,809; of which about 94 per cent. was brought from United States.

Dyestuffs Licences

THE following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during November, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee. The total number of applications received during the month was 762, of which 639 were from merchants or importers. To these should be added 33 cases outstanding on October 31, making a total for the month of 795. These were dealt with as follows: Granted, 693 (of which 662 were dealt with within 7 days of receipt); referred to British makers of similar products, 70 (of which 32 were dealt with within 7 days of receipt); referred to reparation supplies available, 2 (both dealt with within 2 days of receipt); and outstanding on October 31, 30. Of the total of 795 applications received, 728 or 88 per cent. were dealt with within 7 days of receipt.

Manufactured Dyes and the Dye User

Their Importance to the Nation

By Sir Joseph Turner, K.B.E.

Sir Joseph Turner, who has been closely associated with the British dyestuffs industry, deals in the following article with the fundamental importance of the dyestuffs industry to the Empire, and indicates the large part that dyestuffs play in other industries.

A GREAT deal has been said and written regarding dye-making in this country, which is, independent of all others, a key industry. It is fundamental in peace and imperative in war. Its products in peace enter into the lives of the great and the lowly, the rich and the poor, the white and the black. Its products in war turn the balance between victory and defeat. Its world's output is so insignificant that it is lost in the vast total of the world's production. The outputs of the industries built on a supply of dyestuffs are stupendous.

Importance in War Time

Take, for instance, the position of the manufacturer of dyestuffs in relation to munitions of war. England was the birthplace of the synthetic dyestuff industry, as it has been the birthplace of so many other ideas, inventions, and institutions which have been of benefit to man. The dyestuffs industry was first established on British soil and effected its early growth under British control. German chemists, however, some with the knowledge of the British industry, soon laid the foundations of the future German dye industry. Thenceforward, the growth of the British dyestuffs industry decreased, and that of the German gradually increased.

Consequently, when war was declared, Germany had resources from and within the German Empire upon which she could rely for being supplied with the main products essential for war. We should not, however, despise the small British pre-war dyeworks to which I have made reference. As to how far their insistence prevented the German manufacturers from exploiting a monopoly, the British consumers themselves are able to judge. These small factories were capable of being used, and had in fact been used, for the foundation of the greater British dye industry which now exists.

The German Government had merely to turn to the dye-making factories for almost every kind of material they required regarding explosives, etc., and the importance of such an industry in war time is now generally recognised.

Economic Aspects

Of more interest at the moment, however, is the economic aspect of the subject. As is well known, the total value of the dyestuff industry or the total weight of the dyeing materials which it places on the world's market is insignificant in comparison with the whole volume of goods produced in the course of a year, but the quantity and value of the goods into the manufacture of which dyestuffs enter is very large, very important, and forms a considerable percentage of the total output of all goods in the course of a year.

I may illustrate this point by an example. Let us suppose that 2 per cent. of a particular colour is required to dye a particular fabric. This is really above the average in actual practice, but it will serve as an example. This means that 1 lb. of the colour will dye approximately 50 lb. of the material, and if, let us suppose, the material weighs 1 lb. to the yard, 1 lb. of the colour will dye 50 yards of material, or one ton of the colour will dye very much more than 100,000 yards of material. One ton is a small measurement of weight, but 100,000 yards is a large measurement of length.

Contrast with Pre-war Conditions

It will be interesting to examine, so far as is possible, the position as it actually existed in this country before the war. An extremely valuable and interesting volume has been issued by the Board of Trade giving particulars of each kind of dyestuff imported from Germany into Great Britain in the year 1913, and also the total figures of the importations of each important group of colouring matters from Switzerland. These statistics show that in that particular year we obtained about 7,000,000 lb. of direct cotton colours; about 4,000,000 lb. of sulphur colours; about 2,500,000 lb. of Alizarine Red; and about 600,000 lb. of vat colours, all of which would be used in the cotton trade. We also imported about 4,000,000 lb. of synthetic indigo.

If we make some allowance for the amount of indigo used in the cotton trade and for the contributions of domestic manufacturers to the British market in the year 1913, it may be assumed that somewhere between 14,000,000 and 15,000,000 lb. weight of colour (or about 7,000 tons) was used in various branches of the cotton trade in that year. It would be interesting to know exactly the quantity or the value of the products made with these 7,000 tons of colouring matters. Unfortunately there are no total output figures for the United Kingdom for the year we are considering, but particulars of the exports of cotton goods in this particular year are available. Naturally, in this short consideration of the question, I cannot enter into a discussion as to what proportion of the cotton colours was used in industries other than the cotton industry, or as to what proportion of the exports of cotton goods in the year 1913 was made in the preceding year, or made with dyes imported in the preceding year, but I do not think that these considerations would seriously alter the position.

Export Figures

The export figures show that over 36,000,000 lb. weight of dyed cotton yarns were exported in the year 1913, and, turning to printed cotton piece goods, we exported over 54,000,000 yards of flags, handkerchiefs, and shawls in the piece, and over 1,200 million yards of other sorts of printed cotton goods. In addition we exported nearly 1,200 million yards of cotton goods, dyed in the piece, and nearly 300,000,000 yards of piece goods made wholly or partly from dyed yarn. We should also take into consideration the exports of stockings and socks, which amounted to over 720,000 pairs, of lace exported to the value of over £4,000,000 sterling, and of sewing threads exported to the extent of nearly 21,000,000 lb. weight. Some proportion of these latter articles would certainly be dyed.

Returning, however, to the ordinary cotton manufactures, it appears that we exported 36,000,000 lb. weight of yarn and about 2,750 million yards of dyed cotton goods of one sort and another. The weight of the yarn exported alone exceeds the weight of the dye used, and the total weight of all exports must be immensely greater than the 7,000 tons employed in the industry, whilst the value of these exports alone (about £46,000,000) is over twenty times as great as the value of the whole synthetic dyestuffs market of Great Britain, and about three times as great as the whole dyestuff market of the world.

Dyestuffs in Other Industries

It would be interesting to form some idea of the total value of all the goods into the manufacture of which dyestuffs enter, but the calculation is somewhat speculative. To obtain any statistics at all we must deal with the year 1907. It appears that the United Kingdom produced in that year cotton yarns and goods of all sorts to the value of about £132,000,000, woollen and worsted yarns and fabrics to the value of about £63,000,000; jute, hemp, and linen yarns and goods to the value of about £27,000,000, and silk yarns and goods to the value of about £4,000,000, or a total value of £226,000,000. We should require to add to this total the value of other textile manufactures such as hosiery and lace and also of the paper, leather, and straw-plait trades, ignoring other outlets for synthetic dyestuffs. We must allow for the fact that not all the textile articles are dyed or printed, and, moreover, the value of the yarns subsequently woven into piece goods has been counted twice.

There is, however, some justification for believing, on the basis of these figures, that goods to the value of £200,000,000 were produced in the United Kingdom in the year immediately preceding the war, a supply of dyestuffs being indispensable for such goods. The quantity of dyestuffs required was about 20,000 tons, valued at about £2,000,000. One pound's worth of dyestuffs produced, therefore, £100 worth of finished goods. The dyestuff industry gives a return of one-hundredfold.

A Link with Overseas Lands

There is another extremely important point to be taken into consideration with regard to our exports of dyed goods. They are of such a nature, and are in such variety, that they are consumed in all countries of the world, and by all people whatever the state of their civilisation, and British textiles carry the British name and British trade to the most remote corners of the earth. The following particulars are interesting. The various parts of the British Empire received about 60 per cent. of our exports of printed cotton goods, about 43 per cent. of our exports of dyed piece goods and about 30 per cent. of our exports of cotton goods made from dyed yarns.

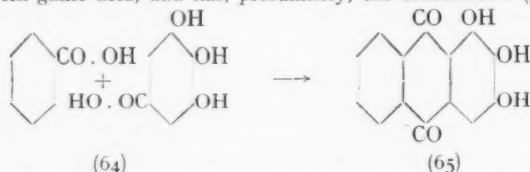
This trade, therefore, is an important link between the Mother-country and its various Dominions and Dependencies across the sea, and it is almost terrifying to think that this vast trade, maintaining commercial contact with the rest of the Empire, and carrying British trade and prestige to the uttermost parts of the earth, was subject to the menace of the German monopoly of the dyestuff industry. It is clear, now

that the facts are known, and everybody realises the position, that it would be immensely foolish ever to allow so important a part of our economic structure to be again subject to the dangers or the influence of any foreign monopoly. Therefore, I state without fear of contradiction that because the dyestuff industry is the basis of so vast an output of British products, because those products are so intimately connected with the growth of Empire relations and with the maintenance of British trades in all markets of the world, that those making those products and engaged in that trade must be able to look to a purely British source of supply of those essential markets, without which their business may vanish almost in a night. I will conclude with the hope that the consensus of public opinion will demand that all steps shall be taken to effect the definite and complete re-establishment of the dyestuff industry in the land of its birth, and that under no circumstances shall any combination ever be made in this special industry with the Germans, which would mean, as everybody knows, a stifling of the progress of the British industry.

Basic Intermediates for Dyestuffs: No. XIII.—The Derivatives of Benzoic Acid

By "Consultant"

BENZOIC acid itself is seldom called upon as an intermediate in the preparation of dyestuffs, although in the older days, when Aniline Blues were in demand, it was used to some extent as a catalyst in the preparation of these rosaniline derivatives. The precise mechanism by which benzoic acid brought about the desired condensations is not yet understood. There is, however, one exceptional dyestuff—Alizarin Yellow A—which demands the use of benzoic acid in its preparation. It may be obtained by the condensation of benzoic acid (64) with gallic acid, and has, presumably, the constitution (65):



The purpose for which benzoic acid is to be used is the deciding factor as to which method of manufacture is to be adopted. Sufficient crude benzoic acid to supply the needs of the dyestuffs industry is, as a rule, obtained by the methods indicated in Part XII of this series for the production of benzaldehyde, but where this is insufficient, the toluene may be chlorinated so that a large proportion of benzotrichloride is produced. It is impossible to arrange the chlorination so that an "almost quantitative" yield of benzotrichloride is obtained, since nuclear substitution of the benzotrichloride already formed invariably sets in towards the end of the process. The mixture of benzotrichloride and benzal chloride obtained in this way may be hydrolysed in the manner indicated under benzaldehyde; in this case the benzoic acid is the main product and a certain amount of benzaldehyde the by-product. Owing to the fact that nuclear substitution cannot be avoided during the chlorination, the final product always contains a small proportion of chlorinated benzoic acids. This renders it quite unfit for use in pharmacy, for which purpose the product must either undergo a long series of purifications (never quite successful in removing the last traces of chlorinated compounds), or else an alternative process for the preparation of the acid must be used. Fortunately, it is comparatively easy to oxidise the methyl group of toluene to the carboxyl group. The reagent used for this purpose is chromic-sulphuric acid mixture.

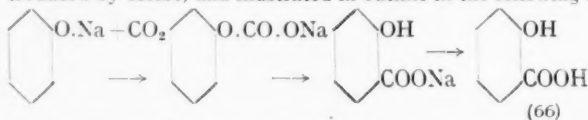
Sulphuric acid (100 per cent.; 3 cwt.) containing about one-third of its weight of chromic acid is heated in an acid-proof vessel to a temperature of 80–90° C., and the vapour of toluene is passed through it by a pipe which passes only a few inches below the surface of the oxidising mixture. Part of the toluene is oxidised to benzoic acid while the rest condenses and forms a layer on the top of the acid mixture. The benzoic acid remains dissolved in this layer, and is thus protected from further action of the reagent. To work this process on the scale indicated requires considerable skill and a rather

complicated plant. The toluene layer is continually removed throughout the process and is scrubbed with soda solution to remove the benzoic acid, or in order to keep the toluene dry it may be removed from the benzoic acid by low pressure distillation before return to the vaporiser. The acid oxidising reagent also forms part of a continuous cycle, and is removed and its chromic acid content regenerated by electrolysis. The process is, therefore, up to a point, continuous, since when the acid reagent becomes too loaded with impurities of carbonisation, etc., for further efficient working, it may be withdrawn and replaced without stopping the plant. In actual practice it is often advisable to stop the plant for internal cleaning operations at this point. The yield of benzoic acid is about 70 to 75 per cent. of the toluene consumed.

Benzoyl chloride finds a limited use in the preparation of dyes of the Algal class and those derived from the benzoyleated aminoanthraquinones. Dyes from benzoyleated aminoanthraquinones have a direct affinity for cotton fibres which is lacking in those which are obtained from the free amino compounds, a fact which is also true of the compounds of the naphthylamine sulphonic acids, although to a more limited extent. The preparation of benzoyl chloride is a simple matter, thionyl chloride being the most suitable reagent for the purpose, since any excess can be readily disposed of, while a product of very high purity results.

Salicylic Acid

Salicylic acid, orthohydroxybenzoic acid (66), is one of the most important derivatives of benzoic acid from the point of dyestuffs manufacture. It is an invaluable end-component in the preparation of azo dyes, and will couple with two molecules of diazo compound, although this property is very seldom made use of. The list of dyes which are prepared from salicylic acid is very considerable, containing the numerous Crumpsall Browns and Yellows and certain of the Dianol Fast Reds and Greens. Salicylic acid is almost invariably made by the carbonation process from sodium phenate, introduced by Kolbe, and illustrated in outline in the following:



The process for the manufacture of salicylic acid divides itself into three distinct stages:—

1. The preparation of completely dry sodium phenate.
2. The carbonation of the sodium phenate, with the consequent formation of sodium salicylate.
3. The isolation and purification of the acid itself.

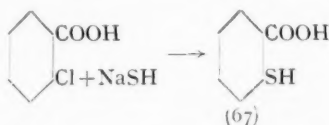
The sodium phenate must be dry and in a very finely powdered condition, or imperfect carbonation results; it is also necessary that the sodium phenate should not be exposed to the air for more than a very short time, since in the finely pulverised state it rapidly absorbs oxygen, leading to discolora-

tion of the final product. Opinion is divided as to whether it is more economical to dry out the sodium phenate in a separate drier or to use the autoclaves in which carbonation will ultimately take place. The principles involved are essentially the same, and the reduction in labour costs, plant, etc., seem to indicate that the latter process is the more advantageous.

In the combined process the autoclaves are arranged with double jackets through which pressure steam or cold water can be circulated, and are made to withstand pressure up to five atmospheres. Very adequate stirring gear is necessary, and it is preferable to have the autoclave with a flat bottom rather than the more usual hemispherical type. As the pressures involved are only comparatively low, this is possible without danger through loss of strength; the advantage lies in the fact that a number of balls may be incorporated with the stirring gear of a flat-bottomed autoclave, thus shortening the time necessary for pulverisation and drying, and producing a more finely divided and more active product. Phenol (188 lb.) is melted and run into the warmed autoclave and the stirring started. The caustic soda (80 lb.) is dissolved in water (12 galls.) and the solution run slowly into the phenol, stirring being continuous throughout the addition. The addition of caustic having been completed, the vacuum is turned on to the vessel, and steam at 80 lb. circulated through the coils. The progress of the drying may be observed by means of an inspection chamber below the condenser which is placed between the autoclave and the vacuum line; when water ceases to drip, drying is nearly completed. The temperature should be between 120° and 130° C. during the drying, and heating is continued for an hour after water ceases to drip in the condenser. Stirring must be maintained throughout. As soon as the charge is dry the vacuum is let off by shutting off the cock to the vacuum line and slowly opening that attached to the carbon dioxide cylinders. In this way contact of the dried sodium phenate with the atmosphere is completely avoided. The carbon dioxide is rapidly absorbed, but care must be taken not to feed it in so rapidly that the charge is overheated, since the reaction is an exothermic one. Carbon dioxide is fed in until a positive pressure of three atmospheres is registered, at which point the supply is reduced and the contents heated by circulating steam through the coils to 120–130° C. The process continues until no more carbon dioxide is absorbed, after which heating and stirring are continued for another three hours. The charge is then cooled somewhat, the excess carbon dioxide blown off into another autoclave, and water is run in on to the charge. The sodium salicylate rapidly dissolves, and is pumped out into vats through a filtering device, and the solution treated rapidly with a very slight excess of hydrochloric acid. The precipitated acid is centrifuged and purified either by distillation in superheated steam or in air at 140° C.

Thiosalicylic Acid

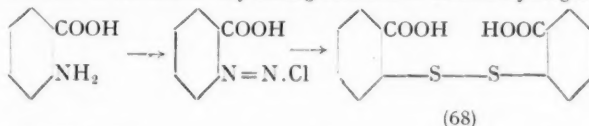
Thiosalicylic acid (67) is almost as important to the dyestuffs industry as the corresponding oxygen compound, although from a different standpoint, namely, the preparation of thioindigoid dyes. The method used for its preparation depends on the raw material available. Where orthochlorobenzoic acid can be obtained in quantity it may be treated in the following way:—



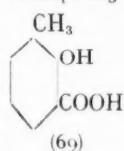
The chloro-acid ($\frac{1}{2}$ cwt.) is stirred with enough water to make a thin paste of the crystals, and is converted into its sodium salt by the addition of caustic soda lye (40° Bé., 8 galls.). To this is added about $\frac{1}{2}$ lb. of copper sulphate solution dissolved in a little water, the copper salt acting as a catalyst for the replacement of the Cl group by the thiol group. Sodium hydrogen (1 cwt.) sulphide solution is then run in with stirring, and the whole heated until the water has been driven off; heating is continued up to a temperature of 150°–170° C., at which point the whole mass, which by this time is dark red, commences to melt. The temperature is still raised, and at 250° C. the mass becomes viscous and

resolidifies. It is then cooled, dissolved in water (100 galls.), and the acid separated by acidification.

A more usual starting point is anthranilic acid, *via* the so-called "sulphydrate Sandmeyer" reaction. The anthranilic acid is diazotised in exactly the usual way and run into a mixture of ice and a very strong solution of sodium hydrogen



sulphide. The reaction indicated by the formula above takes place and in the end dithiosalicylic acid (68) is obtained. This is converted to the desired product by solution in dilute sodium carbonate, and boiling with finely divided iron until a sample upon acidification gives no hydrogen sulphide, and gives a precipitate which is soluble in alcohol. When this stage is reached the thiosalicylic acid is precipitated with dilute acid. It occurs as a yellowish crystalline compound of m.p. 163–165° C.



One further derivative of benzoic acid deserves a passing mention, namely, cresotic acid (69) which was at one time in demand for the manufacture of Cresotin Yellow. It may be prepared from orthocresol in the same way as is salicylic acid from phenol. Its use has, at present, become almost obsolete.

The Dyeing of Growing Timber

FROM time to time attempts have been made to colour the wood of growing trees by injecting dyes at the base of the trunk during the period of the spring rise of sap. Hitherto only measurable success has been secured, as the colours obtained have not been fast. A German process, now under experimental trial in Maine, appears (according to a bulletin issued by A. D. Little, U.S.A.) to have solved the problem. It permits the use of a wide range of dyes, and it is claimed that the resulting colours are not only permanent, but deepen with age. From the woods so coloured many attractive novelties, as umbrella handles, door knobs, brush backs, buttons, and boxes have been made.

The dye is distributed throughout the tree from a reservoir formed by boring a number of 1-in. auger holes in the trunk, about four feet from the ground, and other holes through two or three of the large roots. The dye solution is placed in a 16-gall. container, hung on the tree about 12 ft. from the ground, and connected with the reservoir and holes in the roots by rubber piping. A tree of 15 in. diameter breast high will absorb the contents of one of these containers in about 18 hours, and from 75 to 100 galls. of the dye solution are required completely to colour the tree. There is no question of the beauty or utility of the wood thus dyed, but the operation is rather expensive, as about 6 lb. of dye is needed for an average tree, and the proper shaping of the reservoir involves considerable time and labour. The process seems to suggest new possibilities in the making of marquetry floors, novelties, wood products, and furniture, and if these find favour, the process may afford a profitable outlet for woods for which no favourable market has previously been found.

German Dye Exports

THE statistics for the first quarter of 1927 show that, evidently without detriment to the domestic market, exports from Germany of the more important synthetic dyestuffs have increased. Aniline tar and sulphur dyestuffs exports were 6,963 metric tons, as compared with 4,957 in the same period of 1926. The relative increase in alizarine dyestuffs was even greater, having been 1,235 tons, as compared with 272 tons. Indigo was exported to the amount of 4,517 tons, as compared with 3,942 in the first quarter of 1926. Heavy competition in indigo by three American companies has been mentioned in Frankfort lately, principally with regard to the Japanese and Chinese markets. Apparently, not only the Germans, but also the Swiss, are affected by this competition.

American Dyestuffs and Synthetic Chemicals

Summary of the New Census Return

THE tenth annual Census of Dyes and other Synthetic Organic Chemicals for 1926 has just been issued by the United States Tariff Commission. The report shows that the domestic dye and organic chemical industry made notable progress during the year. Developments from year to year since 1917 in the manufacture of dyes and other finished coal tar products are unparalleled in the history of the American chemical industry. During 1926 domestic dyes supplied 93 per cent. of the apparent consumption, and in addition there was an exportable surplus of nearly 26,000,000 pounds, as compared with 1913, when 13 per cent. of the dyes consumed were produced in the country, chiefly from imported intermediates. It is significant that many of the new dyes are of purely American development.

In 1926 there was notable progress in the manufacture of fast and speciality dyes, including those for dyeing rayon and mixed fabrics. The production of vat dyes established a new record, with a total of over 4,000,000 pounds, as compared with 2,600,000 lb. in 1925. None of these dyes was made in the United States prior to the World War. This class of dyes is used largely in cotton fabrics and yields shades of exceptional fastness to light and to the modern laundry treatment. Many domestic textile manufacturers have in recent years put on the market a variety of fast dyed fabrics of cotton and of linen marked with a trade name bearing a guarantee as to their fastness to washing and light. It is probable that coloured textiles will soon be marked according to their fastness.

Coal Tar Dyes

The total production of coal tar dyes by 61 firms in 1926 was 87,978,624 lb., an increase of 2 per cent. over the previous year. Sales in 1926 totalled 86,255,836 lb., valued at \$36,312,648, at a weighted average of 42 cents per lb., or 10 per cent. less than the corresponding average price during 1925. The average price in 1917 was \$1.42 per lb. The competition between domestic dye manufacturers is severe, and resulted in 16 fewer firms engaged in production in 1926 than in 1925.

The imports of dyes during 1926 represented a decrease of 10 per cent. in quantity and 11.5 per cent. in value, as compared with 1925.

Exports of dyes in 1926 increased slightly in quantity, but decreased 11 per cent. in value, as compared with 1925.

International Dye Trade

Competition among the dye-producing nations of the world has been severe, particularly in the sale of the cheaper bulk colours to China, British India, and other non-producing nations. The trend toward the increased use of fast dyes, including vat dyes and other high-priced colours, continues and promises to increase.

A number of international agreements were negotiated in 1926 between important groups of the producing nations for the purpose of stabilising prices and reducing the severe competition, possibly by a division of world markets. It is reported that the German interests have negotiated agreements with Japanese, French, and Swiss industries.

Germany continues to make organised efforts to regain her former dominance of the world's dye markets. In 1926 the Interessen Gemeinschaft greatly expanded its operations by gaining control of several German chemical companies occupying important positions in related branches of the chemical industry. It is reported that the capital increase of the Interessen Gemeinschaft from 646 million reichs marks in 1925 to 1,100 million reichs marks in 1926 will be used in extending its nitrogen plants and in erecting new plants to utilise the Bergius process of liquefying coal.

Germany has been successful in extending her export trade, particularly in the higher priced dyes; her pre-war trade in the cheap bulk colours, such as indigo and sulphur black, has not been recovered.

In Great Britain the chemical industry was seriously affected by the coal strike of 1926. The British, like the Germans, have formed mergers which make it possible to conclude trade agreements with similar large groups in other countries.

In Switzerland the dye industry has suffered from the effect of increased competition on indigo.

The Italians have begun the manufacture of synthetic indigo, for which they have a modern plant with an annual capacity of over 3,000,000 lb.

The production of coal tar medicinals continued to show substantial progress. The 1926 production of medicinals was 11 per cent. greater than that in 1925, and sales were 9.1 per cent. greater in quantity and 6.5 per cent. greater in value than in the preceding year.

Research now under way points to further discoveries of great importance to public welfare.

Synthetic Organic Chemicals Not Derived From Coal Tar

The manufacture of synthetic organic chemicals of non-coal tar origin is increasing so rapidly that in value of products it bids fair to rival coal tar chemicals in the near future. The production of 214,842,313 lb. in 1926 is a 37 per cent. increase over that of 1925. Sales in 1926 were 168,712,158 lb., valued at \$29,719,270. The manufacture of solvents of non-coal tar origin has reached large proportions. Of these, the largest increase in production was shown in butanol, butyl acetate, ethyl acetate, amyl acetate, and ethylene glycol. Many of these solvents are used in the new automobile lacquers and in the increasingly popular furniture lacquers.

The large production of ethylene glycol in 1926 was of more than usual interest because of its recently developed use as a partial substitute for glycerine in the manufacture of anti-freeze dynamite. Ethylene glycol has promise of an extensive use as an anti-freeze agent for automobile radiators.

Reviews

THE HIGHER COAL-TAR HYDROCARBONS. By A. E. Everest, D.Sc., Ph.D., F.I.C. London: Longmans, Green and Co. Pp. 334. 18s.

The author of this volume is to be congratulated on having broken fresh ground. The substances dealt with include the acenaphthene group (acenaphthene and aceanthrene); the fluorene group (fluorene, fluoranthrene, and truxene); the phenanthrene group (phenanthrene, retene, chrysene, pyrene, picene, perylene, and phenanthroanthracene); benzylthrene; and finally, the hydrocarbons of unknown constitution, crackene, chrysogene, succisterene, and synanthrene. Apart from phenanthrene, most of those mentioned to a large extent await investigation. As far as possible, a complete account of our present knowledge of the compounds and their derivatives is given. Apart from the attraction which the group of substances discussed will have for every organic chemist, it has especial interest from the point of view of possible syntheses of new dyestuffs and therapeutic chemicals. Both as a volume to be perused by those who are seeking unexplored fields for investigation, and as a work of reference, this book can be strongly recommended. F.

INDUSTRIE DER HOLZDESTILLATIONSPRODUKTE. By Dr. G. Bugge. Dresden and Leipzig: Theodor Steinkopff; 1927. Pp. 206. 16.50 marks.

This excellent little volume deals in a comprehensive manner with the dry distillation of wood, and the isolation and purification of its by-products. It is a sign of the times that the book includes also chapters on the synthetic production of methyl alcohol, acetic acid, acetone, and other wood products. It is almost pathetic to read the descriptions of the ingenious apparatus and methods which have been designed to obtain the more valuable wood products in the largest yields and highest purity. Soon, presumably, these processes will become useless on account of the brilliant progress of chemical synthesis. However, the student will always benefit by the perusal of these records of chemical ingenuity. The text is accompanied by numerous references and a number of illustrations. The index—for a German book—is also very good. S. P. S.

Dyes and Their Application : Recent Technical Progress

By L. J. Hooley

The Identification of Dyestuffs

IN the manufacture, use and sale of dyestuffs, frequent occasions arise when it becomes necessary for a colour to be identified. As examples, a dyer may be supplied with a material, which he is to match in shade and fastness, a salesman may have to examine a competitive product, or a maker may require to know the constitution of a new dyestuff. The difficulty of determination will vary in different cases according to the exactitude required. While the elucidation of the structure of a new colour, about which nothing is known, is one of the most difficult analytical problems, involving finally the synthesis of the product for confirmation; it is often possible to find the dyes used in a fabric with sufficient accuracy by a few simple tests. In actual practice, the purpose for which the product is intended, or the circumstances which make examination necessary, generally give an idea of the nature of the colour, and once the class to which it belongs is established, the experimenter is in a much more favourable position if, as will usually be the case, he is already familiar with this class. In some cases a complete solution will be impossible, for there are many commercial products of unknown constitution.

The standard text-book on this subject is Green's *Analysis of Dyestuffs*, which gives systematic methods for examining colours both in substance and on the fibre.

By means of a few systematic tests, the class to which a dyestuff belongs can be found, and then while it is not possible to identify all the dyes in the Colour Index by means of the tables given, these are sufficient to show all the most important dyestuffs, and in many cases to give the particular brand.

In *The Identification of Commercial Dyestuffs*, Mulliken has given data for the recognition of about fifteen hundred commercial products.

Once it has been established that a colour belongs, say, to the vat series, further identification is usually carried out by empirical methods depending upon the colour changes which the dyestuff or the dyed fibre undergoes with a number of common reagents. For this purpose tables of reactions have been made up by colourists, generally in the first instance for their own use. With the provision of such tables and a little experience a large number of dyestuffs can be identified without any knowledge of their chemical constitution.

Acetyl Silk Dyes

One of the latest of these sets of tables has been published by C. M. Keyworth (*J.S.D.C.*, 1927, page 343), for acetyl silk dyes. All the well-known colours of this class have been first divided into groups of yellow, orange, etc., and then the reactions of the dyed acetyl silk with alcohol, acetic acid, hydrochloric acid, ammonia, etc., determined. Including the shade of the dyestuff, there are fourteen reactions for each colour. This large number is a distinct advantage, as while in many cases the dyestuff will have been found by the time a few tests have been carried out, the whole fourteen tests will be of value where there is any doubt.

In examining acetyl silk it is necessary to remember that its comparative impenetrability makes many reactions slower and much less marked than they would be on wool or cotton. That this is a real difference, can be seen by the fact that colours, which can be discharged when dyed on cotton, cannot always be discharged by the same agents when dyed on acetyl silk.

Vat Dyes

Similar tables for the identification of the vat dyes were given by Jones and Kilby in the same Journal (1925, 127). These authors mentioned that it is necessary for the dyer to be able to identify his own dyeings so that in cases of complaints he may be sure he is dealing with his own work. The use of white porcelain basins which they recommended for some of the tests, will be found very convenient, especially if the small flat variety is chosen. Owing to the majority of the vat colours being older than the cellulose acetate ones, it has been possible to classify them under their Colour Index numbers, which avoids any repetition. Other tables on similar lines have also appeared, e.g. Vais (*Textilb.* 1927, 611).

Users of such tables will find it convenient, where a product cannot be found in the table and is therefore new, to keep a record of its reactions. A little discrimination is necessary in detecting dyestuffs by these means. The concentrations recommended by the compilers should be adhered to, for in secondary shades especially, a colour may appear different in different strengths. The colours must also be viewed in a proper light and greater importance can be attached to positive colour changes than negative ones. A colour such as Flavanthrene, which changes from a bright yellow to a deep blue in an alkaline vat and a green in an acid vat will be unmistakable, whilst many of the indigo colours which give pale yellow vats will be more difficult to distinguish. Once the dyestuff has been traced it is advisable, where absolute certainty is necessary, to make a control dyeing and test the two, side by side. With mixtures, one dye can sometimes be removed from the fibre and dyed on another, but this is not generally possible; then, unless the two colours have marked reactions which do not mask each other, it is necessary to make trial mixtures and compare their behaviour with the original. If the sample is a print, pieces of the various colours can be cut out before testing, and where the pattern is a very fine one, this can be done under low power microscope or pocket lens.

Azo Colours

Where an azo compound cannot be recognised by simple means it is usual to reduce it with sodium hydrosulphite or stannous chloride and then identify the amines produced by the fission of the azo linkage. Data of the melting points, crystalline form, salts, etc., by which a large number of important constituents may be recognised, have been collected by W. C. Holmes in the *American Dyestuff Reporter*. The naphthol sulphonic acids, naphthylamine sulphonic acids, etc., are not always easy to recognise, and cannot be determined by melting points. Forster and Hanson have recently worked out a tabular scheme for 39 of the most important of these. A little of the substance is dissolved in dilute ammonia and a filter paper wetted with this solution. Spotting tests are then done on this paper.

Dyes in Substance

With water soluble colours, reactions can be very conveniently done in aqueous solution.

In working with the solid colours the presence of diluents, such as salt, dextrine must not be forgotten. If sufficient material is available the diluent can usually be removed, but if there are only one or two grammes it is wiser to neglect it. For determination of constitution the product must be properly purified first, and then analysed, after this there are no general rules of procedure, other than those adopted in other cases of determination of constitution with organic compounds.

The most characteristic property of a colour is its absorption spectrum, and if this contains several well defined bands it provides an invaluable test for the colour. It has the advantage that it will often distinguish between very closely related types of the same colour which are difficult to differentiate in other ways.

The spectra of a large number of commercial products have been determined and collected by Formänek in *Untersuchung und Nachweis organischer Farbstoffe auf spektroskopischem Wege*.

British Photographic Research Association

THE Department of Scientific and Industrial Research has offered to the British Photographic Research Association a block grant for the five years ending May 31, 1932, that will make up the income of the Association from other sources (its members' subscriptions) to £5,000 per annum. There are certain conditions, and the one that is essentially new requires the appointment of a "research committee of technical and scientific persons in whom shall be vested the supervision of the scientific investigations of the Association."

Dyestuffs Markets: The Month's Business in Review

From Our Own Correspondents

Lancashire

In direct contrast to the weather, November has proved a gloomy month for those interested in the sale of dyestuffs. The actual diminution in volume of business was not great, but the tone of the market is not good, and there can be no doubt that the return to open competition by the spinners of American cotton has had a depressing effect on most of those in contact with the cotton industry. Mr. J. M. Keynes writes in the *Nation* of the desperately discouraging atmosphere of Lancashire to-day towards constructive effort, but northern atmospheres, whether respiratory or industrial, are somewhat complex, and, therefore, difficult to define. If it were possible to lay foundations which had a promise of permanency, then the probability is that interest in constructive effort would appear at once, but is it sound to assume that the foundation-laying stage has been reached? Is it a vain hope to suggest that the atmosphere might even become that of destructive effort without necessarily becoming unhealthy, inasmuch as the rebuilding of any old-established section of the community entails as a necessary preliminary extensive wrecking and clearing operations. It is, of course, more satisfactory if wrecking and clearing are carried out according to a preconceived plan, but at the same time it may be rash to assume that the lack of it means that there is neither method nor design in the processes which are now taking place. In the meantime the general feeling is that affairs will be worse before they are better, and hence the present gloom.

During the month a lecture by Dr. Rath, of the I.G., on wetting-out and dispersing agents, was given under the auspices of the Society of Dyers and Colourists to an appreciative and representative audience of technical people. Under ideal conditions ordinary soap combines in one substance wetting-out and dispersing properties of a high order, but such favourable conditions are only found in a fraction of the wet operations connected with dyeing and finishing, and the present aim of organic chemical manufacturers would appear to be that of discovering substances which have wetting-out or dispersing properties, or both, under the conditions which do not permit of the use of soap. From the discussion it would appear that many problems are not yet solved, and that extra cost more than outweighs the advantages of quicker manipulation of many operations. It is reported that a wetting-out agent embodying recent lines of chemical achievement is at the moment being introduced by the British Dyestuffs Corporation, Ltd.

The absorption of the British Alizarine Co. by Imperial Chemical Industries, Ltd., is now a general market tip, with the result that the British Alizarine shares have reached a price which the earning capacity of the company scarcely warrants. So far no information of any negotiations is available.

Yorkshire

What was said last month of October trading may be said now of the trade of November: there has been a good deal of promise and indication of better business, but prosperity in substance hesitates. Fear of a textile strike has not been evident, our trade feeling that reliance on the prevalence of good counsel would be justified. On the other hand, although the employers' notice to end the wages agreement took effect during the week ending November 26, no settlement appears to have been effected and no work to have been interrupted. The general wages agreement has ceased, but the wages at the same rate continue. The affairs of the textile industry in general have somewhat obscured the wages trouble in the dyeing and finishing sections. The three months' notice given by trade unions in this section to cancel as from January 13 next all wages agreements runs its course without any sign of a move in the matter on the part of the employers; they appear to be waiting patiently to see what will happen after that date. There appears to be agreement on at least one point, and that is the general desire among employers and employees alike to avoid a stoppage of machinery.

In remarking that colours offered by merchants on the Continent to merchants and consumers in England are usually described as 200 per cent. in 300 per cent., a Yorkshire colour

maker asked the writer if he knew whether this description appeared on the application for import licence and on the sample labels so as to ensure a just application of the two times price factor. The writer reluctantly expressed doubt.

Information received of the signing in Frankfurt of the agreement among the European chemical firms for forming a European cartel has given rise to conjecture on the part of those engaged in the trade in this district as to the possible effect on their own businesses. The opinion is expressed that as the agreement covers the selling and export prices of all dyestuffs it should afford in its application some measure of protection for the smaller and outside manufacturer, and that when one realises that the Dyestuffs (Import Regulation) Act has but two years to run, if not renewed, there may be some little comfort and hope to be gained from that view.

An accident involving the death of one man and injuries to three others occurred early last month at the works of the British Dyestuffs Corporation, Ltd., Huddersfield. In constructional work a wooden vat weighing approximately a ton was being raised, and at a height of about 20 feet something failed to withstand the strain, and the vat came crashing to the floor, falling on the unfortunate man who was killed. About the same time a fire occurred at the works of the Yorkshire Coking and Chemical Co., Ltd., Glass Houghton, a large wooden structure becoming ignited owing, it is believed, to a firework thrown through a window. The structure was razed.

The chart of colours just issued by the Bradford Trade Selection Committee for use by spinners and manufacturers in the wool textile area for the coming spring includes "Lido Blue" as one of the principal colours; it is introduced in two tones. The general tendency of the chart appears to be towards fuller and greater depth of tone in all shades; a better sign for the dyestuff maker. There are two distinctive tones of Mahogany, many shades of Rose, Beige, Wedgwood Blue and Leaf Green. Bright Red is a cheery feature and Red Brown continues in favour.

Scotland

November is the last uninterrupted month of the year, and so to a certain extent affords the last opportunity of seeing any considerable variations. The month has been much the same as recent months; there has been no falling below previous levels and in some cases a slight improvement. The general tone, without being disappointing, has been quiet. Greater activity in the dyeing trade can only come after improvements in the staple industries, of which there is little sign at present.

The tweed and hosiery branches are still the brightest spots; the latter is better occupied than during October, and both are practically running on full time, being kept busy largely by increases in export orders. The uncertainty in connection with the wages position, which is at present depressing the Yorkshire woollen industry, does not seem to be having a corresponding effect in Scotland. Dyers and printers of cotton goods are sharing the present unsatisfactory conditions in the cotton trade.

J. and P. Coats announce an interim dividend of 3 $\frac{3}{4}$ per cent., payable December 31, which is the same as that for last year. A week or two ago there was some excitement on rumours of impending connection with the Nuera Artificial Silk Co. This appears to have originated in a purely private interest of two of the directors of Coats.

There has been some discussion in the linen industry on possible means of improving the home trade, which has now been very low for some time. A suggestion has been made that the industry as a whole has not devoted sufficient attention to the advertisement of its goods, the wholesaler leaving it to the retailer and *vice versa*. At a time when there is not the same tendency as there used to be to buy materials with the longest wearing capabilities, but to get a less durable material which can be more easily replaced, it can be seen that there is some possibility of the outstanding properties of linen being overlooked.

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The Determination of Vanadium in Metallurgical Products

By W. Singleton

The methods for the determination of vanadium which are described below are particularly applicable to ores, ferro-vanadium, and steel. Existing methods for the determination of vanadium and its separation from other metals are discussed, and attention is directed to electrometric methods.

It has been shown by various investigators, in regard to the estimation of vanadium in steel by reduction with ferrous sulphate and titration with potassium dichromate, using potassium ferricyanide solution as an outside indicator, that with an increasing vanadium content the potassium ferricyanide is reduced by tetravalent vanadium, and therefore gives a low reading for vanadium. Various other indicators have been suggested, particularly diphenylcarbazide, which has been used by numerous investigators. Using this substance, Etheridge (*Analyst*, Vol. 48, 588 (1923)) has worked out a volumetric method for the determination of vanadium in steel which gives results correct to within 0.02 per cent. on steels containing up to 2 per cent. of vanadium; in steels containing more than 2 per cent. of chromium the end point is obscured by the green coloration of the chromic sulphate. In carrying out the titration in the presence of chromium the green colour of the latter can be considerably reduced by a suitable addition of cobalt sulphate. Conversely, a cobalt steel may be titrated in the presence of chromic sulphate.

Use of Diphenylamine as Indicator

Freeman (*Ind. Eng. Chem.*, Vol. 17, 314 (1925)) suggests the use of diphenylamine as an indicator in the reduction of vanadic acid. The blue colour which diphenylamine gives with oxidising agents such as dichromates and vanadates in acid solution is discharged by the reducing action of ferrous sulphate and stannous chloride. By using an empirical correction for the quantity of reducing agent required to decolorise the indicator, fairly accurate results may be obtained in the determination of vanadium in steels. The procedure to be adopted is essentially that of Willard and Fenwick, which is described elsewhere in this article. The method due to Jaboulay may be carried out in the solution in which chromium is determined volumetrically with ferrous sulphate and potassium permanganate. It is based upon the fact that vanadic acid can be reduced with ferrous sulphate and the excess of the latter oxidised with potassium dichromate, which in small amounts has no effect on the subsequent titration of the divanadyl salt with potassium permanganate.

One gram of the steel is dissolved in dilute sulphuric acid, and nitric acid added drop by drop until effervescence stops and the iron has been oxidised. The solution is gently boiled and a saturated solution of potassium permanganate very slowly added until a slight precipitate of manganese oxide persists. After diluting to 200 c.c. and boiling for ten minutes, the precipitated manganese dioxide and tungstic oxide are filtered off. If chromium is present it may be determined in the usual way by adding a slight excess of ferrous sulphate solution and titrating back with potassium permanganate. The solution is cooled, and ferrous sulphate added in slight excess, using potassium ferricyanide as an outside indicator. The solution is diluted to about 700 c.c., 1 c.c. of 0.1 N potassium dichromate added to oxidise the excess ferrous sulphate, and the titration carried out immediately with 0.1 N potassium permanganate. Nickel if present may cause high results by its green colour. If a determination of iron and vanadium is to be made after reduction with hydrogen sulphide, the following modification is to be recommended. In the reduction of iron compounds and vanadates by hydrogen sulphide, some polythionic acid is usually formed and is

likely to cause results which are too high if the solution be titrated immediately (Lundell and Knowles, *J. Amer. C.S.*, 1560 (1921)). The determination is reasonably accurate if the solution to be reduced does not exceed a volume of 100 c.c., and the acidity is approximately 2 to 2.5 per cent. by volume. If high accuracy is required it is advisable to remove any metals of the copper-tin group present.

Where only small amounts of vanadium, in the absence of chromium, are to be determined, and where rapidity is desired, a modification of Johnson's method has been found satisfactory. The sample is dissolved in 25 per cent. sulphuric acid and oxidised with nitric acid. After filtering off any graphite or silica, the solution is collected in a 400 c.c. beaker and heated to just below boiling. A 10 per cent. solution of potassium permanganate is carefully added from a pipette with constant stirring and until a faint pink coloration is obtained, great excess being avoided. The pink coloration fades to brown and then to yellow, but when a clear reddish-brown coloration persists for 2 or 3 minutes a further drop of potassium permanganate is added, the solution stirred, and removed from the hot plate. If manganese oxide be formed it will need filtration. The solution is now diluted to 300 c.c. and reduced with standard ferrous ammonium sulphate solution, and the titration completed in the usual manner with permanganate.

Determination of Vanadium in Iron Ores and Ferro-Vanadium

For the separation and determination of vanadium, chromium, and titanium in iron ores the following preliminary treatment is recommended: 8 to 10 g. of the ore are digested with concentrated hydrochloric acid. The iron is reduced by sulphur dioxide; and by adding sodium carbonate and boiling, titanium, chromium, aluminium, and vanadium, together with phosphorus, arsenic, and molybdenum, are precipitated. By fusion with sodium carbonate and potassium nitrite, the aqueous extract can be analysed for chromium, vanadium, etc., and the residue for titanium. For ferro-vanadium, 0.2 g. of the alloy are dissolved in aqua regia, evaporated to white fumes of sulphur trioxide with 15 c.c. of concentrated sulphuric acid, and diluted to a volume of 250 c.c. The solution is then carefully oxidised with a little potassium permanganate, after which it is diluted, and a further 10 c.c. of sulphuric acid and an excess of standard ferrous sulphate solution added. The excess ferrous sulphate is titrated with standard potassium dichromate solution, using diphenylcarbazide in acetic acid as indicator. The American Society for Testing Materials recommend a somewhat similar process for ferro-vanadium.

The following method for the quantitative determination of vanadium in steels and iron alloys gives results accurate enough for most practical purposes. E.g., 0.5 g. ferro-vanadium is heated in an iron crucible with six times its weight of sodium peroxide. The melt is taken up with water, acidified with hydrochloric acid and silica filtered off. From the filtrate the iron and chromium are removed by treatment with boiling caustic soda solution, after a preliminary treatment with ether to remove the greater part of the iron. The solution is cooled and made 1 per cent. acid with respect to hydrochloric or sulphuric acid, and a 4 per cent. solution of cupferron added. The precipitate is filtered off and washed

with a 2 per cent. hydrochloric or sulphuric acid solution containing 2 per cent. of the cupferron solution. The precipitate is dried at 70° C., burnt, and ignited to constant weight as vanadium pentoxide. For steels, the hydrochloric acid solution is obtained according to Blair's method. Silica and tungsten are eliminated by filtration, and iron removed by extraction with ether. The solution containing chromium and vanadium is boiled with caustic soda solution and filtered, and the filtrate treated with lead acetate or acetic acid and lead nitrate. The precipitated lead vanadate is collected and dissolved in dilute hydrochloric acid, treated with concentrated sulphuric acid and evaporated to fumes of sulphur trioxide. The residue is taken up with water and the vanadium determined in the filtrate as above.

The Colorimetric Determination of Vanadium

The formation of pervanadic acid by the action of hydrogen peroxide may be used as a means for the determination of vanadium provided sufficient care is taken to avoid interfering colorations by other metals. Those produced by iron and tungsten are counteracted by the use of ortho-phosphoric acid, and that due to carbon is removed by means of oxidation with potassium permanganate or ammonium persulphate. The colorations due to nickel and chromium are not easy to discharge, and in the presence of these metals it is advisable to use a standard containing the same quantity of nickel and chromium as in the steel under examination. In the analysis of steels containing less than 0.5 per cent. of vanadium 0.2 g. of steel is sufficient, and if larger amounts of vanadium are present, 0.1 g. The sample is dissolved in 3 to 5 c.c. of a solution containing 90 per cent. of 6 N sulphuric acid and 10 per cent. ortho-phosphoric acid (s. g. 1.2). The solution is oxidised with 1 c.c. of nitric acid (s. g. 1.18) and heated until nitrous fumes are no longer evolved. The solution is washed into a beaker with cold distilled water, 1 c.c. of 10 per cent. ammonium persulphate added, and the whole heated until no further gases are evolved. The liquid is transferred to a 50 c.c. colour-matching cylinder, treated with 3 per cent. hydrogen peroxide, and compared with standard vanadium colorations. If the original steel contained nickel or chromium, suitable amounts of nickel or chromium sulphates are added to the standard. The determination may be made within an hour.

In another method, 1 g. of the steel is dissolved in 20 c.c. of nitric acid (s. g. 1.2). 10 c.c. of an 8 per cent. solution of potassium permanganate are added and the solution boiled to destroy organic matter. Any precipitated manganese oxide is redissolved by the addition of 10 c.c. of a solution of sodium peroxide in dilute nitric acid (4 g. in a mixture of 10 c.c. acid with 90 c.c. water) and subsequent boiling. A further 5 c.c. of the sodium peroxide solution are added, the whole diluted to 80 c.c., and the vanadium determined colorimetrically.

The Iodimetric Determination of Vanadium

In an alkaline solution or neutral buffer solution, trivalent vanadium is oxidised to the pentavalent condition by iodine, whilst in an acid solution pentavalent vanadium is reduced by iodide ion. The reduction may be made to proceed to the trivalent condition at very high concentrations of acids and iodide, but it stops at the tetravalent state over a wide range of acid and iodide concentrations at about 15 to 20° C. Stoppel, Sidener, and Brinton (*J. Amer. C. S.*, Vol. 46, 2448 (1924)) have described a rapid and direct iodimetric method for determining vanadium. The treatment of the solution with hydrogen peroxide in alkaline solution is recommended, to make sure that all the vanadium is in the quinquevalent state, excess of hydrogen peroxide being removed by boiling. To the concentrated solution containing 0.08 to 0.25 of vanadium pentoxide in a total volume of 5 to 10 c.c., an equal volume of 6 N hydrochloric acid and 2 to 4 g. of potassium iodide are added, the vanadium being reduced to the quadrivalent condition. The solution is diluted to 200 to 300 c.c., and the iodine titrated with a standard solution of sodium thiosulphate.

The reduction of pentavalent vanadium in concentrations of acid and iodide in which it is reduced to the tetravalent state often gives high results for iodine. Edgar has pointed out that the oxygen of the air is responsible for the oxidation of the iodide ion and is catalysed by pentavalent vanadium. Stoppel and his co-workers claim that in their method the

catalytic effect of pentavalent vanadium is not operative. Ramsey (*J. Amer. Chem. Soc.*, Vol. 49, 1138 (1927)) shows that over a wide range of acid and iodide concentrations the method due to Stoppel and his colleagues gives quite accurate results when oxygen is excluded from the solutions used, but that otherwise more iodine is always formed than that equivalent to the vanadium present.

Electrometric Methods

Methods employing the measurement of the change of oxidation potential during titration, or, as they are more generally known, electrometric titration methods, are of particular importance to the chemist employed in the analysis of special steels. Kelley and Conant first determined vanadium potentiometrically by titrating it with a standard ferrous iron solution, and Willard and Fenwick (*J. Amer. C. S.*, Vol. 45, 84 (1923)) used the method for the determination of vanadium in the presence of iron and chromium. Treadwell used the oxidation of vanadyl salts by potassium permanganate for potentiometric titrations, and Muller and Just have recommended it (*Z. anorg. allg. Chem.*, Vol. 125, 155 (1922)). Vanadic acid, H_2VO_4 , is reduced by zinc and sulphuric acid to vanadium monoxide, V_2O_3 , which can be titrated, potentiometrically, with potassium permanganate and shows three breaks in the titration curve corresponding to vanadium monoxide, tetroxide, and pentoxide.

Kolthoff and Tomicek (*Rec. trav. Chim.*, Vol. 43, 447 (1924)) state that the determination of vanadic acid, H_2VO_4 , in the presence of iron is not difficult, except in the presence of chromic acid. They have attempted to determine both vanadium and chromium in the presence of each other, by using a mixture of ammonium vanadate and potassium dichromate of known composition, and titrating with a standardised solution of ferrous ammonium sulphate, in the presence of carbon dioxide. Only one break in potential occurred, and this corresponded accurately to the known composition of the mixture. Vanadium and chromium may also be determined potentiometrically in the presence of large amounts of iron. After having determined the sum of the vanadium and chromium present, the vanadium is determined alone, thus: The solution is first titrated with potassium permanganate at room temperature until a break occurs in the potential. The titration is completed at 70° C. The amount of reagent used between the first and second break in potential gives the vanadium. The first break in potential indicates that the excess ferrous salt is completely oxidised. This method gives accurate results in the presence of chromium.

Determining Chromium and Vanadium in Steel

In steel analysis, some difficulty may be experienced in completing the oxidation of the chromium, but this may be obviated in the solution, slightly acid with sulphuric acid, by boiling for half an hour whilst adding an excess of ammonium persulphate. For the determination of chromium and vanadium in steel, the following procedure is recommended. 2 to 5 g. of the steel, if containing less than 2 per cent., are dissolved in nitric acid (s. g. 1.18), and the solution evaporated quickly. The nitric acid is removed by evaporation with concentrated sulphuric acid, and the residue taken up in dilute sulphuric acid and filtered. The residue of iron and manganese, containing silica, may be disregarded if only small in amount, but otherwise it must be dissolved by further acid treatment or alkaline fusion and added to the main solution, which must always be converted into sulphates and made up to a definite volume. A portion is used for the determination of vanadium, and another portion for vanadium plus chromium. The potential of the solution against a platinum electrode should be less than 0.5 volt towards a normal calomel electrode. Should the potential be larger, a slight excess of the ferrous iron solution must be added to the portion used for the determination of vanadium. The solution is brought to a concentration of between 0.4 and 0.8 N sulphuric acid, the volume to about 175 c.c., and the titration with N/20 potassium permanganate carried out as previously described. The second portion, for the vanadium plus chromium, should be only slightly acid. 5 g. potassium persulphate are added to the solution, which is diluted to 150 c.c., boiled for 10 minutes, cooled, and filtered if necessary. The solution is acidified, and titrated electrometrically with N/20 ferrous ammonium sulphate.

The previously mentioned method of Willard and Fenwick for the electrometric titration of vanadium in the presence of iron and chromium has been found to give quite satisfactory results. The use of a polarised bi-metallic electrode system provides a sensitive means for determining the end point in the reduction of vanadic acid with ferrous sulphate. In acetic acid solution the reduction of 6-valent chromium can be accomplished by hydrogen peroxide without affecting 5-valent vanadium, and the results are better than when nitric acid is used for the selective oxidation of vanadium. In the presence of large quantities of phospho-tungstate and phosphomolybdate, traces of vanadium may be titrated by this method. The procedure recommended in the analysis of chrome-vanadium steels is as follows. The steel sample, containing about 10 mg. of vanadium, is treated with 25 c.c. water and sufficient concentrated sulphuric acid added from a pipette to form ferrous sulphate with all the iron and leave about 4 c.c. in excess. The solution is heated gently until the metal is dissolved and crystals begin to form on cooling. The solution diluted with 20 c.c. hot water, and heated until all salts are dissolved, 4 to 5 c.c. of concentrated nitric acid are added, and the liquid boiled, the oxidation being completed with a slight excess of permanganate solution. Sufficient sodium acetate to combine with all the excess acid, and 40 to 50 c.c. of glacial acetic acid are added, together with about 0.5 g. of neutralised sodium perborate. The solution is diluted to 200 c.c. and boiled 20 minutes. After cooling, 25 c.c. concentrated hydrochloric acid are added, and the vanadium in the solution titrated with 0.02 N potassium dichromate solution.

Kelley and his co-workers (*Ind. Eng. Chem.*, Vol. 11, No. 17, 632 (1919)) describe a method which permits of the direct determination of vanadium in the original solution of the steel sample, accurately and rapidly, the method being based upon the selective oxidation of vanadium by nitric acid, followed by electrometric titration with ferrous sulphate. This does not give as good results as the method of Willard and Fenwick.

The method of Muller and Just for the electrometric determination of vanadium and iron when present together, is based on the fact that ferrous solutions are more vigorous in their reducing action than are vanadyl solutions. If potassium permanganate is added slowly to a mixture of these solutions the first sudden change in E.M.F. corresponds to the complete oxidation of the iron, and the next sudden change indicates the oxidation of the vanadium. Vanadium can be reduced to the bivalent condition by passing the acid solution through a zinc reductor. By titrating with potassium permanganate, the bivalent vanadium can be oxidised back to the quinquevalent state. If the electrometric titration takes place at 70° C. distinct breaks in the titration curve are obtained which correspond to the oxidation of the vanadium to each of the higher valencies. None of these three breaks are very evident in titrations carried out at room temperature. In the presence of iron there are four breaks in the curve, the oxidation of the iron taking place after the oxidation of the vanadium to the quadrivalent state and previous to the oxidation of vanadium to the quinquevalent state. At 70°, the iron titration is not sharp, and at room temperature the vanadium titration is indistinct. Müller and Flath (*Z. Elektrochem.*, Vol. 29, 500 (1923)) find that this difficulty can be overcome by titrating hot, until two end points are obtained, corresponding to the oxidation of vanadium through two stages, and then titrating cold, until the iron is oxidised, finally titrating the hot solution till the vanadium is completely converted back to the quinquevalent state.

Similarly uranium and iron can be titrated electrometrically, in the presence of one another, a break in the curve showing the oxidation of uranium from the valence of four to six, and another break, the oxidation of the iron. When vanadium and uranium are both reduced by zinc three end points are obtained at 70° C. The first corresponds to the oxidation of vanadium from the valence of two to three, the second, the oxidation of vanadium from the valence of three to four and the oxidation of uranium from four to six, and the third the oxidation of vanadium from four to five. Iron, uranium, and vanadium when together can also be determined by reduction with zinc and titration with potassium permanganate in acid solution. When titrating hot, the first end point is the oxidation of vanadium from a valency of two to

three, the second the oxidation of the vanadium from three to four and of the uranium from four to six, the third (best obtained by titrating in the cold solution), the oxidation of the iron. A further hot titration shows the oxidation of vanadium from four to five. Gustavson and Kundsén (*J. Amer. C.S.*, Vol. 14, 2756 (1922)) have studied the successive electrometric titration of vanadium, uranium, and iron by working on solutions containing salts of these metals alone and in combination. The elements can be titrated electrometrically after reduction with zinc and sulphuric acid, but in the case of vanadium it is essential that the titration should be carried out in the absence of air or oxygen.

Darwins, Ltd.: Petition for Winding-Up

On Tuesday, in the Chancery Division (companies winding-up), Mr. Justice Eve had before him the petition of Williams Deacon's Bank, Ltd., for the winding-up of Darwins, Ltd., steel manufacturers, of Sheffield. The petitioners were the company's bankers, who were creditors for a large sum. The petition was opposed by Mr. P. R. Kuehnrich, chairman and managing director of the company, a creditor for £3,255 and holder of 105,000 fully paid ordinary £1 shares. He stated in an affidavit that he had been endeavouring to make arrangements whereby all creditors' claims would be met in full. Counsel for Mr. Kuehnrich said he would apply for a further adjournment, as he was in negotiation with an American company, and he had left for America on Saturday last to see if he could arrange finances there. He suggested an adjournment for 14 days. Mr. Kuehnrich added that the work in hand at the works gave an excess of profits of £500 or £600 a week, after paying all expenses. Counsel for a shareholder holding 180,000 preference and 8,000 ordinary shares supported the application for an adjournment for 14 days. Counsel for Mr. Kuehnrich suggested that the matter should stand for three weeks. The petitioner did not oppose the adjournment, and the company supported it. His lordship ordered the matter to stand over for three weeks.

Selective Flotation for Canadian Ores

THE Mines Branch of the Dominion Department of Mines at Ottawa has just issued Memorandum No. 29, dated March, 1927, dealing with "Selective Flotation as Applied to Canadian Ores." The memorandum, which is by Mr. C. S. Parsons, engineer, Division of Ore Dressing and Metallurgy, recalls that Canada possesses many deposits of complex ores such as lead-zinc-iron sulphides, copper-zinc-iron sulphides, copper-iron sulphides, and other combinations of these minerals, many of which contain values in both gold and silver. The Mines Branch of the Department of Mines, through its ore dressing and metallurgical laboratories at Ottawa, has made numerous investigations into the treatment of such Canadian ores by selective flotation. The purpose of this review is to bring more directly to the attention of the mining public the information which has been acquired and the progress which has been made in the treatment of ores by this method, and also to point out the assistance the Government is rendering the mining industry by maintaining at Ottawa fully equipped ore dressing and metallurgical laboratories for research on the treatment of ores and metallurgical products. A brief description of the flotation equipment of these laboratories is given in order that the reader may better realise the type of work which can be performed. Copies of the memorandum will be available shortly for distribution by the Natural Resources and Industrial Information Branch, The Canadian Building, Trafalgar Square, London, S.W. 1.

Soft Steel: German Claims

REPORTS from Germany state that an Essen firm claims to have discovered a steel-aluminium alloy, having very important properties, and known as "soft steel." It is said to be very strong, easily worked, and non-corrodible by salt water. Hence claims are made for its utility in shipbuilding, railway coach building, land and sea aircraft, etc.; and it is further stated that the electrical conductivity of the substance makes it a useful substitute for copper. An American concern is reported to be attempting to acquire the rights for the manufacture of "soft steel" in the United States.

Metallurgical Topics: Monthly Notes and Comments

From Our Own Correspondents

The Testing of Materials

THERE is a movement afoot on the Continent for the revival of the International Association for the Testing of Materials, which before the war had its headquarters in Vienna, and branches in various countries. The movement is likely to meet with a good deal of opposition, at any rate in this country. The old Association was a somewhat irresponsible one, and while it did a certain amount of good and useful work in the direction of investigating and attempting to standardise methods of testing, which are sadly in need of systematic correlation, it somewhat overstepped its functions by dabbling with the question of international specifications for materials. The British Engineering Standards Association has done excellent work in drawing up standard specifications, and in some instances prescribes a standard method of testing. The question of international specifications is one which is likely to prove evasive and irritating. National materials and processes differ so greatly that it is hardly possible to conceive of international specifications of a nature likely to fit in with existing national ones.

Proposed Conference at Amsterdam

THE methods of testing employed to ascertain whether materials, and particularly metallurgical materials, comply with the specifications laid down by various bodies, fall into two classes: chemical tests and physical tests. Few chemists would agree to having the conditions and methods under which they conduct chemical analyses stringently laid down. Such a procedure would involve a host of subsidiary rules, regulations, and specifications as to the reagents, and even the apparatus employed. There are usually several alternative ways of conducting an analysis, and their relative accuracy is fairly well known. In any case, however, standard specifications and methods of testing are hardly ripe for internationalisation, and the British delegates at the forthcoming Conference at Amsterdam will hold a careful watching brief that nothing shall be done which might ultimately prejudice British interests in this delicate question.

Pure Metals and Single Crystals

AMONG the most attractive of the many interesting researches in progress in the metallurgical department of the National Physical Laboratory are those relating to the preparation, properties, and behaviour of pure metals, and those relating to the properties and behaviour of large single crystals. At any rate, it was to these investigations that many of the visitors to Teddington, on the occasion of the annual inspection by the Board, last week, paid most attention, notwithstanding the interest displayed in the foundry as well, where die casting and other operations were being demonstrated. Pure metals are *sui generis*. Their properties cannot necessarily be predicted from research work on metals that are not pure. All that can be inferred is that the purer a metal the more truly constant its various properties will prove. Dr. Vernon's corrosion report seems to suggest that so far as corrosion resistance is concerned, the behaviour of relatively pure metals is no better and no worse than that of ordinary crude metals. It would be interesting to know, in greater detail, upon what facts this conclusion was based, as it seems to conflict with actual experience, as well as to run counter to the theoretical notions of how pure metals should behave as compared with impure ones. Some, but not much, work on these lines has been done at the National Physical Laboratory, but excellent progress has been made in other directions.

Specific Properties

ENOUGH information has now been accumulated to allow of a broad generalisation to the effect that the electrical conductivity of pure metals is greater than that of metals which are not pure. As to the thermal conductivity the results are less definite. The lattice structure is, as might be anticipated, unchanged. Other properties have not been broadly differentiated. Research work on single crystals is, as yet, in a distinct category, for most of the large single crystals hitherto produced are not of very highly pure metal. An exception may be perhaps made in the case of copper and

zinc, for very pure large metal crystals have been produced in both metals. The most striking phenomenon in the case of copper is its enormous capacity for strain hardening at the slightest provocation. Zinc proves ultra ductile, but is brittle as well, an awkward combination of properties. In the case of iron, the kind known as ingot iron is generally selected, sometimes without much regard for its origin. There is a good deal of material masquerading under this name which is very far from pure. It is as well for those anxious to obtain the purest iron to be warned beforehand that not all "ingot iron" is necessarily pure.

Pure Beryllium

THERE are reasons for supposing that pure beryllium, free from nitrogen, would be a very ductile metal. On this account, and generally in order that trustworthy data regarding the properties of this metal may be obtained, the metallurgical department of the National Physical Laboratory has for some time been engaged in efforts to prepare the metal in a suitable state of purity. The method now under investigation is that of filament deposition. The purest beryllium obtainable by other methods, together with some iodine, is placed in a specially constructed glass vessel, into which is fused a tungsten filament. The whole apparatus is placed in a furnace and maintained at 400°C., while the filament is heated by the passage of an electric current. The iodine attacks the beryllium, yielding beryllium iodide; this undergoes thermal dissociation, and since the partial pressure of the metal thus formed is greater than its vapour pressure at the same temperature, pure beryllium, free from nitrogen, is deposited on the filament. The method, though new as regards its application to beryllium, is not new in principle, having been used by the Philips Co. in Holland for the production of pure zirconium, hafnium, etc. So far the workers at the National Physical Laboratory have been concentrating on the production of a suitable apparatus, the construction of the latter having involved glass manipulation of quite unusual difficulty. This particular aspect of the problem has now been solved, and while everything is by no means plain sailing (the determination of the temperature of the filament, for example, presenting considerable difficulty), it is likely that results of considerable importance will be forthcoming in the near future.

Some attention has also been paid to the production of pure beryllium compounds from minerals. A routine method of purifying crude beryllium hydroxide has been worked out. It makes use of the fact that beryllium has a great tendency to form basic salts. Crude beryllium hydroxide is added to pure beryllium sulphate solution, in which a very considerable quantity of it dissolves, with the production of basic salts in solution. On dilution, pure beryllium hydroxide is precipitated. As regards sources of beryllium, it should be noted that, in addition to Canadian minerals, beryl of Australian origin is now being used. It seems to be felt pretty generally that (as in the case of aluminium) an ample supply of the necessary raw materials will probably be forthcoming if a careful search is made.

Impact Tests

THE impact resistance of steel varies, as is well known, with the temperature, but it may be doubted whether the great importance of this factor in impact resistance tests is fully appreciated. Even during the operation of testing, precautions should be taken to ensure uniformity of temperature in order to avoid discordant or even misleading results being obtained. Korber and Pomp, in a recent investigation carried out at the Kaiser Wilhelm Institute at Dusseldorf, laid down the rule that test pieces about to be subjected to impact resistance tests should be kept for at least half an hour beforehand in a bath of oil or water at 20°C. to give the most uniform and concordant comparative results. In regard to circumstances in which shock resistance in the cold has to be withstood, wrought iron is often preferred, because the influence of the hot deformation to which it is subject during manufacture is less enduring than that of hot deformation in steel; that is to say, the impact resistance, in the case of wrought iron, suffers less alteration during forging and rolling,

than does that of mild steel. By suitable heat treatment, however, the grain growth in the mild steel may be modified and the properties rendered more akin, so far as impact resistance is concerned, to those of wrought iron. Such heat-treated mild steel can, therefore, be safely substituted for wrought iron, when required.

Impact Strength at 200° C.

At 200° C. mild steel is less brittle than at ordinary temperatures, as measured by its impact resistance. It is, therefore, peculiarly suitable for parts which are habitually subject to this temperature, such as boiler plates, chains for ladles, and similar purposes. For the same reason, it is inadvisable to let plant and machinery worked at this or higher temperatures cool much below it. The cause of cracks developing in casting ladles, for example, is that the impact resistance of the metal, which may be quite high enough for satisfactory service at high temperatures, falls dangerously at normal temperatures. In all cases, in order to ascertain how a metal will behave in practice, impact resistance tests should be carried out under definite temperature conditions, and records made, for purposes of comparison, at 100° C., 200° C., and 300° C., as well as at 20° C. The real impact resistance is a function of the maxima and minima revealed at these varying temperatures.

Aluminium Bronze

ALUMINIUM bronze, by which is usually meant the 10 per cent. aluminium alloy, is rapidly growing in favour, and, as Dr. Reader has pointed out in a paper read at the recent meeting of the American Foundrymen's Association, is capable of application in fields far wider than those in which it is at present employed. Moreover, its properties can be considerably improved by the addition of other elements, notably iron, nickel, and manganese. By the addition of from 1 to 2 per cent. of lead useful anti-frictional properties can be developed, but additions of tin and of silicon reduce the ductility to a serious extent. With 3 per cent. of iron the tensile strength increases to 40 tons per square inch, the yield point being about 40 tons and the elongation about 20 per cent. Further additions of iron impair the ductility and may lead to unsoundness. The 3 per cent. iron aluminium bronzes are suitable for die castings, owing to the chill effect further improving the mechanical properties. The influence of nickel raises the tensile strength even higher than in the case of iron, but the ductility is so much reduced as to restrict the range of usefulness. With 1 per cent. of manganese the tensile strength becomes nearly as high as when 3 per cent. of iron is added, and the abrasion resistance is improved. Aluminium bronzes can be quenched and annealed to confer a wide range of properties and are, in this respect, superior to other copper-rich non-ferrous alloys.

Modern Steelwork

Modern Steelwork, a review of current practice in the application of structural steelwork to buildings and bridges, edited by the late Mr. E. F. Etchells, has just been published by Nash and Alexander, Ltd. (pp. 189, 5s.). It contains a number of semi-technical articles by architects and consulting engineers, including Dr. Oscar Faber, Mr. J. A. Sharman, Mr. T. S. Tair, and Mr. E. S. Andrews, on various aspects of the problem, together with a collection of illustrations and descriptions of modern contracts both in bridge and building construction. Among others, there are sections on "The Manufacture of Rolled Steel Sections"; "Some Aspects of Steel Frame Construction"; "Construction in Relation to Architectural Design"; "Floor Loads"; "The Cost of Steel Frame Buildings"; "Some Effects of Modern Conditions on Design, etc." There is a profusely illustrated section of fifty pages, dealing with some recent steel frame buildings, which gives a good view of the present position. Various tables of standard specifications, etc., are given.

Iron and Steel Institute: Autumn Meeting

THE Iron and Steel Institute are to hold their autumn meeting this year in Glasgow. The technical meetings will be held in the Royal Technical College, and the social meetings in the Central Station Hotel. The members, who will be the guests of the West of Scotland Iron and Steel Institute, will arrive on the evening of Monday, September 19, and on Tuesday morning they will be received in the Technical

College by Mr. John Craig, C.B.E., president of the West of Scotland Institute. On the same day a number of papers will be read, there will be luncheon in the hotel, an official reception by the West of Scotland Institute, and in the evening a municipal reception in the City Chambers. On Wednesday more papers will be read, the members will be entertained to luncheon by the Glasgow Chamber of Commerce, and in the evening the members of both societies will dine together. On Thursday, after the reading of papers, the party will be entertained to luncheon by the president and reception committee of the West of Scotland Institute, and on Friday there will be a sail down the Clyde on the turbine steamer *King George V*. The arrangements are all being made by a committee of the West of Scotland Institute, including the president and Mr. Douglas A. McCallum, the honorary secretary. Among the visitors there will be Mr. Frank W. Harbord, president, and Mr. G. C. Lloyd, secretary of the Institute; and also experts in steel production from France, Belgium, Germany, and Italy, in addition to those from England.

The Copper Monopoly

IN a recent statement in the House of Commons, the President of the Board of Trade, Sir P. Cunliffe Lister, stated that he was aware that a large proportion of the producers of copper in the United States had formed a company to regulate the sale of raw copper outside that country, and that important European interests were also parties to the arrangement. He was further informed that since the formation of the company the prices quoted to British consumers had frequently been higher than the equivalents of the prices quoted to American consumers. It was clearly of great importance that British users of copper should be able to obtain supplies on terms as favourable as those given to their competitors, and he would welcome the development of copper production and refining within the Empire.

United States Manganese Needs

THE United States, by far the largest producer of iron and steel, depends almost wholly upon foreign countries for the manganese which is an essential in the industry, according to the United States Bureau of Mines, Department of Commerce. In 1925, the last year for which figures are available, 890,428 tons of high-grade manganese ore were used in the United States, 615,000 tons being imported during the year. The United States uses approximately 35 per cent. of the world's annual output of high-grade manganese ores, but its contribution to that output is only 4 per cent. More than 92 per cent. of the manganese now utilised goes into the manufacture of steel. Under present practice, manganese is essential in the steel industry. For many of the minor uses of manganese there are substitutes. Manganese is a constituent in various alloys, including ferromanganese, spiegeleisen, manganese bronze, silver bronze, and silicospiegel. It is used as an oxidiser in dry batteries; in the decolorising of glass; in the drying of varnishes and paints; in the preparation of oxygen; and in the manufacture of disinfectants. It is used as a colouring material in glass, pottery, tiles, and brick, in calico printing and dyeing, and in certain paints.

The world at present depends upon four great sources for its manganese: Russia, India, Brazil, and the Gold Coast. In 1925 the world's production was approximately 2,570,000 tons, of which Russia produced 32 per cent., India 24 per cent., Brazil 12 per cent., and the Gold Coast 13 per cent. The Tchiaturi deposit, in the Province of Kutais, Republic of Georgia, south of the Caucasus, may be classed as the largest single deposit of manganese ores now known. It covers some 22 square miles, and estimates of the total commercial ore range from 44,000,000 to 200,000,000 tons. In the United States the production of manganese, except during a few years prior to the advent of the Bessemer and open-hearth processes for making steel, has never been able to satisfy the domestic demand. The occurrences of manganese in the United States are, broadly speaking, well known, and if the past history of mining of this metal is taken to indicate the trend of the future, the country does not possess a supply that can meet its demands. Unless methods are evolved for beneficiating low-grade manganiferous ores, it must remain dependent upon foreign sources as long as manganese is required in the manufacture of steel.

Trade, Commerce, Finance: The Month in Review

From Our Northern Correspondent

THERE has been no real change in the condition of the iron and steel trade during the past month. Business is following the course on which it has been set for several weeks, that is to say, it is gradually settling down to a state of dullness compared with the activity which characterised the opening months of the year. The peak of production has been reached, and outputs are now declining owing to the lack of the orders necessary to keep the plants in full operation. The inflow of new orders is still very unsatisfactory and nothing like sufficient to replace the outgoing deliveries. Furnaces are being laid off, and advantage is taken of such opportunities as are provided by holidays or stocktaking to cease operations for a week or so. Already the feeling is abroad that there is no likelihood of an improvement before the autumn.

Business, and the expectations of it, run in fairly definite grooves. No one expects a recovery to commence in the summer, yet everyone looks forward to the autumn for better trade, and this year of abnormal conditions is no exception. The artificial nature of the boom-like conditions which prevailed immediately after the termination of the coal strike is more clearly realised by both buyers and sellers, and whilst the works are getting anxious about the lack of orders, consumers are effectively following a policy of caution, and slowly but surely forcing prices down. Officially there is still no change in prices fixed by the associations, but when actual business is offered there is no difficulty in obtaining some reduction; and that means that sooner or later, the official prices will be reduced.

Prospects for Steel Prices

In any case, the altered situation in regard to fuel is bound to be reflected in the prices of steel. Consumers know that apart from the increased cost of fuel caused by the strike, and the abnormal demand for steel due to the accumulation of work, there was no other justification for an increase in the price of steel; and now that both these causes have disappeared, the increase will have to go. In fact, in many instances it has already been conceded, and for some classes of steel the selling price is at or below the pre-strike price. It is only a question of time, and not a long time at that, before all prices follow suit. Whether the trade can afford to reduce does not seem to enter into the question. The huge losses which were the legacy of the stoppage arouse no sympathy among the buyers of iron and steel, and each works has to bear its burden as best it can. The inexorable law of supply and demand will compel the reduction, and it can be expected at any time now that the supply has overtaken the demand.

The fuel position, although it promises to be very helpful to the iron and steel works, is a very unhappy one for the colliery owners. Both coal and coke are a drug on the market. Millions of tons of coal have been raised for which there is no demand, and the consequence of this state is seen in the prices at which coal is being sold. House coal and steam coal are not wanted, and industrial coal is not much better. A striking impression of the state of the industry is gained when one sees the hundreds of wagons of coal standing in the railway sidings up and down the country. Many of the pits are working only two or three days a week, the result being that production costs are increasing. Faced as they are with these two problems, increasing costs and falling prices, the collieries are in an unenviable position. The wages earned by the miners are often barely sufficient for subsistence, and unless an improvement soon takes place there may be further trouble with the men. The possibility of a further stoppage in October is being talked of, but if the men realise, as they surely ought to, that their present hardship is the direct outcome of the strike, they will not be likely to rush into another.

The Coke Position

The coke makers are no better off. The output is in excess of the demand, and there appears to be no alternative but to put out some of the ovens. The price has fallen even more than coal, and it is possible to book forward contracts at 22s. to 13s. at the ovens. The tables have indeed been turned! It is a very short time ago since the coke makers were fleecing the ironmasters, and now the coke makers are

forced to accept prices which are less than those ruling prior to the strike, and are even little more than pre-war prices. It is an impossible position, and there is bound to be a stiffening in price before long, as the present figure means a loss which can be endured only for a short time. However, the iron and steel trade is just now in a position to take advantage of these abnormal conditions.

The unsatisfactory state of the iron and steel trade is, of course, common knowledge, and many are the suggestions put forward for effecting an improvement. The possibility of the imposition of a tariff on imported steel is not altogether ruled out, although it is exceedingly remote, as there are too many warring interests to allow such a scheme to go through. Another remedy which was suggested at the annual dinner of the National Federation of Iron and Steel Manufacturers was horizontal amalgamation amongst the steel-producing firms, so as to effect economies in both production and administration. That also is not a practical solution.

Amalgamation or Individualism

There have already been numerous instances of this kind of amalgamation, and it must be admitted that they have not turned out a success. They have not produced economies in working and they have not promoted efficiency; indeed in some cases the opposite effect has been achieved; there has been more dissipation of effort and an addition to the burden of cost rather than a saving. Some of the units which have joined these amalgamations are now repenting it, as they find that they are definitely worse off than they were in their single state. It has been pointed out previously that there is not the right spirit between the various works to make possible such arrangements as are in force in Germany, and individualism prevails in spite of the so-called amalgamations. It is very probable that the most fortunate concerns and the most likely to weather the storm are those who have retained their single blessedness, and by the exercise of rigid economy in their own house and the maintenance of an up-to-date plant are holding their own, or at the worst, giving way very slowly, so that when the tide has turned they are ready to move forward. Sooner or later there will have to be a weeding out amongst the British steel works, and those plants which are incapable of being economically run will have to be scrapped so that the productive capacity will be more in keeping with the normal demand.

The Iron and Steel Market

During the past month the pig iron market has shown no signs of renewed life. Orders are scarce and prices are dropping. No. 3 foundry iron in Lancashire and the Midlands is offered at 70s. at the furnaces, which, after taking into consideration the extra cost due to increased railway rates on raw materials, is about the same price as that ruling before the strike. Yet even at this low price buyers are not tempted to do business, and the orders that come through are for very small parcels. The makers are endeavouring to maintain the 70s., but they feel themselves that they will have to give way. Some of them have taken the bolder step of damping down the furnaces, as stocks are rising and the present cost of manufacture is too high to warrant the holding of large stocks.

Bar iron is in a similar predicament. The marked bars maintain their hold on the special markets which they have established at home and abroad, but there is not a great deal of business; while the crown iron makers are extremely doleful.

The market for finished steel is very quiet. There are far more people wanting to sell than there are buyers. Prices remain at about the same level as last month, although instances of underquoting the association prices are more general. The competition from the Continent is increasing, and in every quarter one hears of the large amount of foreign material which is now being used. The prices are so much below the home prices that it is exceedingly difficult to check the competition.

The output of pig iron for May was 720,100 tons, compared with 680,000 tons in April. At the end of the month there were five furnaces less in blast than at the beginning. The output of steel ingots and castings amounted to 882,500 tons, compared with 850,100 tons in April.

Some Inventions of the Month

By Our Patents Correspondent

Abstracts of other Patents of metallurgical interest will be found in our Patent Literature published weekly in THE CHEMICAL AGE.

Antimony and Tin

DIFFICULTIES are often experienced in leaching antimony from ores, especially ores such as antimony-tin ores which require roasting prior to leaching. The roasting converts the antimony into a higher oxide, which is almost insoluble in acid. According to a patent by the Zinnwerke Wilhelmsburg G.m.b.H., of Wilhelmsburg-on-Elbe, Germany, the leaching can be satisfactorily effected if the ore is subjected to a reducing process either prior to or during the leaching. Thus the ore may be roasted with 5 to 10 per cent. of a reducing agent, such as charcoal, or the ore may be leached with acid containing reducing metal salts, such as cuprous or ferrous salts. By these means antimony, and also copper, bismuth, arsenic, and most of the lead, can be removed from a tin ore, which can then be directly treated in the reverberatory furnace. See Patent No. 268,278, having the International Convention date March 29, 1926.

Pure Iron

THE metallic iron prepared by decomposing iron carbonyl is contaminated with carbon and oxygen. It is now found that the latter elements can be eliminated almost completely by melting or sintering the metal while excluding oxidising gases. Preferably the metal is heated first in vacuo and finally for a short time in an inert gas such as nitrogen or argon. A final carbon content of 0.03 per cent. or less can be attained. See Patent No. 269,345, by J. Y. Johnson, London (from I.G. Farbenindustrie Akt.-Ges., Frankfurt-on-Main, Germany), having the date May 10, 1926.

Nickel

NICKEL or ferro-nickel is prepared from nickeliferous ores by melting them with iron which serves to reduce the nickel. The nickel-iron alloy may be freed from iron by oxidation or may be used repeatedly for the treatment of further ore. See Patent Application 269,133 by M. Stern, Essen, Germany, having the International Convention date April 7, 1926.

Iron and Steel

ACCORDING to F. W. Corsali, Berlin, when melting metals in a shaft furnace with an addition of silicon, manganese, or other substances, the latter are added to the furnace at a point below the melting zone. They may be melted before addition or may be added in the form of briquettes. Various arrangements of furnace are described for effecting the process. See Patent Application No. 267,972, having the International Convention date March 19, 1926.

According to a Patent application by F. Krupp Akt.-Ges., Essen, Germany, articles are to be made of highly deoxidised ingot iron or steel so that in the "aged" state there is no appreciable diminution in the tenacity of the notched bar under test. The deoxidation is effected by addition of aluminium, titanium, zirconium, vanadium, magnesium, or silicon, etc.; a trial rod is cut off, artificially aged and submitted to a cutting test. The quantity of deoxidant is varied until the test is satisfactory. See Patent Application 268,716, having the International Convention date April 3, 1926.

According to a patent application by E. G. T. Gustafsson, Stockholm, fine grained coke or charcoal obtained directly by coking or carbonising materials such as bituminous coal, sawdust or sawmill waste, is used for reducing oxide ores of iron, zinc, copper, etc. The coking may take place in the reduction furnace or in a compartment thereof. See Patent Application 269,179, having the International Convention date April 10, 1926.

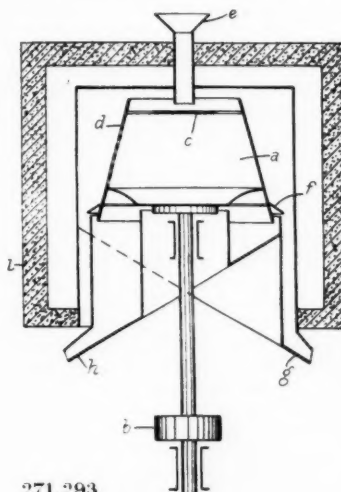
Alloys

In a patent by H. G. C. Fairweather, London, from Etablissements Metallurgiques de la Gironde, Paris, are described a series of light alloys containing 1.5 to 5 parts of copper, 0.3 to 3 parts of nickel, 0.2 to 2 parts of tungsten, 0.2 to 2 parts of magnesium, and 97.8 to 88 parts of aluminium. Some of them can be repeatedly melted without change, and others

after casting, rolling, and annealing have a tensile strength of 36 kg. per sq. mm., with 22 per cent. extension. See Patent No. 270,824, having the date February 17, 1926.

H. Limbourg, of Uccle, Belgium, finds that alloys containing 75 to 85 per cent. of gold, 10 to 15 per cent. of palladium, and 2.5 to 10 per cent. of platinum are useful substitutes for platinum and of considerably lower price. They resist the action of concentrated acids, caustic soda, or potash solution, fused alkali carbonates and nitrates, and are but little attacked by fused caustic soda. See Patent No. 270,974, having the date November 27, 1926.

According to a patent by K. Schmidt, Neckarsulm, Württemberg, Germany, alloys are separated into the various components which separate from the fused alloy on cooling by centrifuging. The metal heated to the appropriate temperature for the separation of a particular constituent is introduced into the centrifuge and the solid separated from the liquid. The method is particularly suited to the treatment of easily fusible alloys such as lead-silver alloys. In the apparatus described a rotating shaft with driving pulley *b* carries a drum *a* consisting of a conical basket *d* and a disc *c* on to which the liquid alloy is fed by the funnel *e*. The liquid portion escapes by the outlet *g* and the solid granules



at *h*. The centrifuge is surrounded by an insulating casing *i* provided with thermostatically controlled heating means. See Patent No. 271,293, having the date August 10, 1926.

Vanadium

PHOSPHORUS is removed from acid leach liquors containing valuable metals such as zinc, copper, or vanadium by adding a ferric salt and then neutralising the solution to cause precipitation of ferric phosphate. By adding further base, silica, iron, and alumina can then be eliminated. In the case of solutions containing vanadium the latter should be in the tetravalent condition. Reduction of the pentavalent vanadium can be advantageously effected by adding ferrous sulphate; the ferric salts so produced then serve for the precipitation of phosphates. See Patent No. 269,778 (R. H. Stevens, G. C. Norris, and W. N. Watson, of Broken Hill, Rhodesia), having the date August 23, 1926.

The same patentees describe a related method for the purification of vanadium-containing solutions, and the separation of vanadium from the purified solutions. The impure solution such as is obtained by leaching vanadium minerals with sulphuric acid is first treated with a reducing agent to convert the vanadium into the tetravalent state. Impurities can then be removed by known methods without precipitating the vanadium. The latter is then reoxidised to the pentavalent state, for example, by means of manganese dioxide, and finally precipitated as ferric vanadate. The reduction is conveniently effected by means of ferrous sulphate, the ferric salts formed being then available for the precipitation of the vanadium at the later stage. See Patent Nos. 269,779 and 269,780, having the date August 23, 1926.

Current Articles Worth Noting

We give below a brief index to current articles in the technical Press dealing with metallurgical subjects.

ALLOYS.—Thermal changes in iron manganese alloys, low in carbon. Sir R. Hadfield. *Proc. Roy. Soc. A.*, June 1, pp. 120-132.

Tensile tests on alloy crystals. I, II, and III. C. F. Elam. *Proc. Roy. Soc. A.*, June 1, pp. 133-147, 148-166, 167-169.

ANALYSIS.—The determination of tungsten in ferrotungsten and tungsten steel. L. Moser and K. Schmidt. *Z. angew. Chem.*, June 9, pp. 667-668 (in German).

Contribution to the determination of small quantities of zinc in pure aluminium. W. Böhm. *Z. anal. Chem.*, Vol. 71 (7), pp. 243-246 (in German).

CORROSION.—Second experimental report to the atmospheric corrosion research committee (British Non-Ferrous Metals Research Association). W. H. J. Vernon. *Trans. Faraday Soc.*, April, pp. 113-204.

ELECTROMETALLURGY, ETC.—The electrolytic separation of metallic chromium from chromic acid solutions. J. Stscherbakow and O. Essin. *Z. Elektrochem.*, June, pp. 245-252 (in German).

Common properties of addition agents in electrodeposition. IV. Effects of various conditions on crystalloidal addition agents. G. Fuseya and N. Nagano. *J. Soc. Chem. Ind. Jap.*, May, pp. 188-191B (in English).

GENERAL.—The formation of carbides in the systems metal-carbon-hydrogen and metal-carbon-oxygen. G. Meyer and F. E. C. Sheffer. *Rec. Trav. Chim. Pays-Bas*, June 15, pp. 359-368 (in French).

On some special cementations of aluminium and duralumin after double electrolytic deposition. J. Cournot and E. Perot. *Comptes Rend.*, May 23, pp. 1250-1252 (in French).

The surface tension of molten metals and alloys. II. The surface tension of tin, lead, antimony, copper and tin-bismuth, lead-bismuth, copper-antimony, and copper-tin alloys and cast iron. J. Drath and F. Sauerwald. *Z. anorg. u. allg. Chem.*, June 14, pp. 301-320 (in German).

IRON AND STEEL.—The action of pure carbon monoxide on iron at elevated temperatures. W. P. Fishel and J. F. Wooddell. *Trans. Amer. Soc. Steel Treating*, May, pp. 730-740. Pure carbon monoxide reacts with iron at temperatures between 800° and 1,100° C. to form iron carbide (Fe₃C) and carbon dioxide. The depth of case increases with temperature, while the maximum carbon content in the case decreases. Total carbon introduced increases with temperature. Both carbon monoxide and dioxide penetrate iron very slowly at 950° and 1,100° C. This rate would not account for the depth of case produced by carbon monoxide.

The decomposition of the austenitic structure in steels. IV and V. R. L. Dowdell and O. E. Harder. *Trans. Amer. Soc. Steel Treating*, May, pp. 781-790; June, pp. 959-974. Part IV reports tests to determine the effect of stress on the stability of austenitic structures. An effort has been made to distinguish between the effects of compression and tensile stresses. Part V gives the results of the application of the powder method of X-ray analysis to the study of changes in the structure of steel on heat treatment. The results are in general agreement with those previously reported as obtained by microscopic examination.

Production and uses of special steels for automobile parts. F. Dagner. *Continental Met. Chem. Eng.*, June, pp. 163-164, 168 (in English).

Comparison of the alloying elements chromium, nickel, molybdenum, and vanadium in structural steels. H. J. French. *Trans. Amer. Soc. Steel Treating*, June, pp. 845-884. A brief discussion is given of the effects of chromium, nickel, molybdenum, and vanadium in structural steels. Comparisons are made of commercial low-alloy steels containing one or more of the specified elements on the basis of their making and shaping, machining, heat treatment, etc. The current high-alloy steels for resisting corrosion or high temperatures are described and consideration given to wear as affected by each of the elements mentioned. The report is a condensed summary of important characteristics of

alloy steels containing the specified elements, and is illustrated by practical applications.

SINGLE CRYSTALS.—The thermal and electrical conductivity of a single crystal of aluminium. E. Griffiths. *Proc. Roy. Soc. A.*, June 1, pp. 236-241.

Etch planes in metallic single crystals. H. H. Potter and W. Sucksmith. *Nature*, June 25, p. 924.

SINGLE METALS.—The preparation and some properties of pure metallic silicon. R. Hölbling. *Z. angew. Chem.*, June 9, pp. 655-659 (in German).

Raw materials for the production of aluminium. A. Sulfrian. *Continental Met. Chem. Eng.*, June, pp. 172-174 (in English).

WELDING.—Tension tests of spot-welded aluminium. T. W. Downes. *Chem. Met. Eng.*, June, pp. 359-360.

The Sorby Lectures

THE fourth Sorby Lecture, "Methods of Growing Large Metal Crystals," delivered last October by Professor H. C. H. Carpenter, F.R.S., has just been published (pp. 31, 1s.), and copies may be obtained from E. J. Thackeray, Department of Applied Science, The University, Sheffield. The lecture provides a very interesting account of the subject, to the advancement of which the author himself has, of course, made considerable contributions. The three previous lectures were delivered by Mr. W. G. Fearnside, Professor C. H. Desch, F.R.S., and Dr. W. Rosenhain, F.R.S., respectively. The lectureship was instituted to commemorate the work of Dr. Henry Clifton Sorby, F.R.S., who rendered such signal service to science in general, and to the special branch of microscopy in particular. It is desired to have a lecture delivered each year by an eminent scientific authority on some subject which arises out of Dr. Sorby's work, and thus to promote an increased interest in scientific research. It is intended that the lectures so delivered shall be published and sold at a nominal sum. In order to do this work effectively it is necessary to raise funds from amongst those who are interested in this important work. At present the scheme is being worked by a committee from the following Sheffield societies and sections of societies: Society of Engineers and Metallurgists, Metallurgical Association, Institute of Metals, Institute of British Foundrymen, Junior Institution of Engineers, and the Sorby Scientific Society. The committee appeals for funds for the purposes of the lectureship. Contributions may be sent to Mr. E. J. Thackeray, at the above address.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

[NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]

BRITISH GRIFFIN CHILLED IRON AND STEEL CO., LTD. (late BRITISH CHILLED IRON AND STEEL CO., LTD.), Barrow-in-Furness. Registered June 2, £1,000 debentures, part of £4,000; general charge. *£9,000. April 16, 1927.

ERVEDOSA TIN MINES, LTD., London, E.C. Registered June 9, £2,500 debentures part of £50,000; charged on company's mines, etc., at Ervedosa, Portugal, also general charge. *£7,000. January 14, 1927.

KRYN AND LAHY METAL WORKS, LTD., London, S.W. Registered June 11, £2,000 debentures, part of £10,000; general charge. *£25,000. December 31, 1926.

UNITED STEEL COMPANIES, LTD., Sheffield. Registered May 26, £500,000 debenture to Branch Nominees, Ltd., 15, Bishopsgate, E.C.; charged on certain lands, mines, premises, etc., also general charge (subject to existing charges). *£874,850 A debentures, £999,100 B debenture stock, £499,998 C debenture stock, £366,574 14/10 mortgages and secured loans. November 8, 1926.

Monthly Metallurgical Section

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NOTICE.—Communications relating to editorial matter for our Monthly Metallurgical Section should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Communications relating to advertisements and other business should be addressed to the Manager. Contributions will be welcomed from correspondents on any points of interest to metallurgists bearing on works practice or current research problems.

Development of Electric Brass Melting in the United States Increasing use of the Method

The subject of electric brass melting has been attracting a good deal of attention lately, and the following account of the position in the United States should be of great interest.

THE electric melting of brass has passed out of the experimental stage and is now a commercial process, but in no country has it been so extensively adopted as in America, which was the pioneer country in the development of this form of melting. An enormous amount of experimental work was carried out, and very extensive trials were made with many types of furnace before this stage was reached. It is but natural that the commercial application of electric melting in America is well ahead of that of other countries, for the development appears to have been almost entirely American. Now that furnaces are available which satisfactorily melt brass on a commercial scale, it is not surprising that manufacturers in other countries are adopting the method where their particular needs and conditions of working justify the expense and dislocation involved in changing over to this from other forms of melting.

The performance of furnaces such as the Ajax Wyatt, which have become almost standard for certain conditions of working and types of metal, are fairly well established, so that the deciding factors as to whether such a furnace in a given works could be profitably operated are limited to initial cost and the economies which such a furnace would offer over existing melting methods. There can be no doubt that for certain conditions of working, electric brass melting offers great economic possibilities, the furnaces in operation in America and the increasing number in use and in the course of construction in other countries, bearing witness to this fact.

The History of the Method

A very informative paper, concerning the development of brass melting in the United States, was recently read by A. W. Gillett before the American Electrochemical Society. The application of the electric furnace to brass melting is comparatively recent, and the history may be divided into three five-year periods: 1912-1917, experimentation; 1917-1922, commercialisation; 1922-1927, standardisation. A large number of distinct types of furnaces have been fairly extensively tried, but only about a dozen have been in commercial service, and when the application of the electric furnace for brass melting had passed beyond the experimental stage only two types of furnace—vertical ring induction and rocking-arc—were at all widely used. This is more or less the position to-day, but a third type of furnace, the Ajax Northrup, of medium frequency, is also becoming of commercial importance. The reflected heat type of furnace is now but little used.

Electric brass melting in the United States has now reached very considerable dimensions, and, considering how short a time has elapsed since the process was in the experimental stage, the development has been very rapid. About 90 per cent. of the brass output of rolling mills and nearly 30 per cent. of the output for foundries is melted in electric furnaces; this amounts to a little more than 50 per cent. of the total output. There are 125 more electric furnaces melting brass than are melting steel in the United States, and a further comparison of the proportion of electrically-melted metal in the brass and steel industries is very interesting. While 90 per cent. of wrought brass is electrically melted, electrically-melted steel production is 90 per cent. only in the case of tool steel. Alloy steels constitute only 3 to 5 per cent. of the total steel production, and of the alloy steel output only 15 per cent. is electrically melted.

As a result of experience and the fuller knowledge thereby gained, some standardisation has been brought about in the last few years. The vertical ring induction furnace—that is, the Ajax Wyatt—is more particularly suited to continuous working, such as is met with in rolling mills, and to alloys containing not more than 90 per cent. of copper. Some manufacturers, however, find that this furnace is not satisfactory for alloys containing more than 75 per cent. of copper, because of the comparatively short life of the lining. The rocking-arc type of furnace is more applicable to conditions obtaining in foundries, but is also used in rolling mills for higher copper alloys. About 25 per cent. of the electrically-melted brass for rolling mills is made in rocking-arc furnaces while about 12 per cent. of the electrically-melted brass from foundries is made in induction furnaces. These two chief types of furnace produce about the same annual tonnage in the whole industry, and the estimated amount of electrically-melted brass for rolling mills is about twice that of foundries.

The Economies Effected

Some interesting figures are given to illustrate the influence of electric melting in the brass industry with respect to savings effected. It is claimed that they show a net melting loss at least 2 per cent. lower than that of the fuel-fired furnaces they replaced, this saving amounting to 13,500 tons of metal per annum. For 1926 the average output was 1.91 pounds per kilowatt-hour, and it is estimated that for the total brass melted electrically in rolling mills and foundries, the fuel used for electrical energy was 44,400 tons less than that which would have been required for melting the same quantity of metal in coke-fired furnaces. In rolling mills, the melting furnaces generally run 24 hours a day, and, consequently, show low interest and depreciation charges per ton. As the chief product of rolling mills is high zinc brass, which cannot be satisfactorily melted in open-hearth furnaces, the pit-fired coke furnace was used. The decided saving in crucible and labour costs, made possible by electric furnaces, led to their speedy adoption as soon as experiments and experience had shown that a commercially satisfactory type was available, and before 1926, the brass rolling mill industry, as a whole, or at least those mills whose output was sufficiently large to influence the statistics of the industry, had adopted electric melting.

In sand casting foundries, furnaces do not usually run more than one shift, and the melting efficiency is, therefore, lower and interest and depreciation charges higher per ton than they would be in continuous melting. Further, the output of many plants is not sufficient to keep a furnace working continuously. Precisely what output is necessary before an electric furnace can be operated with advantage cannot be definitely stated, since it varies, somewhat, with local conditions, but the figures given vary between 2,500 pounds and 1,000 pounds per day. Since much more red brass and bronze than yellow brass are melted in foundries, and the former alloys, being low in zinc, can be melted in reverberatory or open flame furnaces, electric melting has been adopted to a much smaller extent than in rolling mills. About 70 per cent. of the foundry output is not electrically melted, 40 to 45 per cent. being melted in open flame or reverberatory furnaces, and only 25 to 30 per cent. in crucibles.

Further, the fuel cost in open flame furnaces is lower than with crucibles, and since crucible costs do not exist, and the first cost of this type of furnace is much lower than that of an electric furnace, the margin of saving, by electrical replacement, is not so marked. While good quality metal can be produced in open flame furnaces, much more constant watchfulness and skill on the part of the operator is required than for the electric furnace, and, in the latter, cheaper raw materials, such as borings, can be more satisfactorily and economically melted, but the outstanding advantage of the electric over the open flame furnace is its lower metal loss.

For the rocking-arc type of furnace the tendency is to reduce the size and increase the relative energy input, and while some furnaces of one ton capacity are in use, smaller sizes down to 350 pounds and less are more in favour, for it is realised that a small furnace, driven at a high rate, is more

effective than a large one worked at a moderate rate. An Ajax Northrup furnace, of medium frequency, has been developed, but has not yet been at all extensively adopted for brass melting, but the high frequency furnace appears to be very suitable for cupro-nickel and nickel silver and alloys too high in copper to melt satisfactorily in furnaces of the Ajax Wyatt type. The medium frequency furnace is finding application for the melting of tool and other special steels which are usually melted in crucibles.

All three types of electric brass furnace operate on the principle of internal heating or its equivalent, which makes for efficiency; they all stir the metal and so yield uniform material, and it is claimed that under most conditions they are an improvement on fuel-fired furnaces in showing a reduction of metal losses and in the conservation of both metals and fuels.

M. C.

Permanent Moulding Machines

An Interesting Development

In THE CHEMICAL AGE of April 30 a report was given of a discussion by the Chemical Engineering Group of "Permanent Moulding Machines for Cast Iron," when Professor J. W. Hinchley read a paper on the plant used by the Holley Carburettor Co., of Detroit, U.S.A. A further note on the plant used by this company appears below.

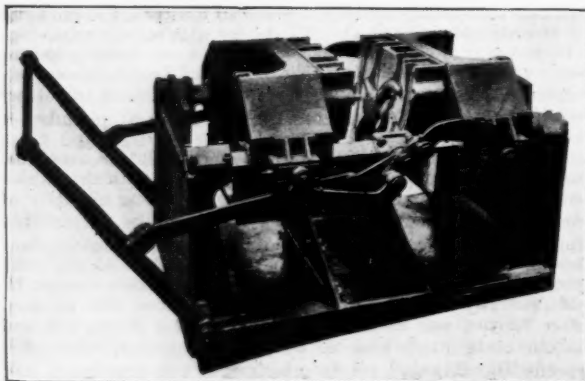
THE foundryman has always felt that the destruction of the mould every time a casting is poured is an inefficient procedure. There is no objection to this method in the case of a special casting, when only a single one is required, but in the casting of many articles of one kind the method is slow and costly. While the iron mould has been used for years and is to-day attracting world-wide attention in connection with the centrifugal casting process, the method in its simpler forms has never found a solid footing in foundry industry, principally because the molten metal when poured in an iron or steel mould is subject to entirely different influences than is the case with

freezing point and conductivity of the molten metal. The temperature of any point of contact between mould surface and molten metal will be practically the same at first, but the depth to which the comparatively high temperatures will penetrate the double coating of fire clay and lampblack and pass into the mould mass will naturally depend upon the heat resistance of this coating, and also on the thickness of the metal which has to set against it. The mould can be of any material that is structurally safe to hold the refractory surface true and well bonded, and will also absorb the heat passed through the mould material and promptly dissipate it. A cast iron backing to a refractory mould material forming a contact surface for the molten iron is an ideal combination when the refractory facing of the mould is thick enough to transmit heat at the proper safe rate, and the iron backing is light enough to dissipate the heat transmitted into it quickly.

The everyday practical application of the foregoing principles has been worked out in a system by the Holley Carburettor Co. which is covered by twenty-two United States patents with 132 claims, and numerous other patents controlled by the Holley Carburettor Co. in Great Britain and many other countries.

The moulds used in the Holley permanent mould process are light, hollow, cast iron moulds, the surface of which is covered with a thin layer of highly refractory material, and this refractory material protected from abrasion and penetration by means of the thick coating of lampblack, so that only after prolonged usage does it need to be patched or refaced. The refractory material forming the mould surface consists of the refractory material itself with a binder to bind the refractory particles together.

These moulds are placed on a revolving table, or "merry-go-round," and successively follow their prescribed course. In passing around, the two parts of the mould are drawn apart sufficiently to allow the setting of cores, but just before the core is set each mould successively passes a flame of acetylene gas which smokes the inner surfaces for the purpose of superimposing a relatively thick ($\frac{1}{8}$ in.) layer of carbon between the refractory surface and the molten metal. After passing the flame the core is set in place, the two parts of the mould are closed automatically and are held together by means of spring pressure during the pouring period and until the metal has sufficiently set. Then they quickly open and the castings are forced out automatically by ejection pins. Next, a blast of compressed air quickly blows the surfaces clean and the mould passes before the acetylene flame again. If the moulds are designed for additional air cooling the machine can be run at a higher speed, in which case this air is supplied by an ordinary low pressure blower. One man can pour 400 castings an hour in one machine equipped with twelve single moulds, or one-eighth the number of man hours necessary to pour the same number of castings in sand.



LARGE SINGLE MOULDING MACHINE

the ordinary sand mould. The rate of cooling is so much faster, with consequent more sharply defined crystallisation effects and production of very fine grain structure, if not actual chilling of the metal to whiteness.

Conditions that had to be considered in developing the Holley process were: (1) Mould surfaces had to be of a highly refractory character so that the least possible heat is transmitted inward to affect the form of the mould and in order not to limit seriously the rate at which the moulds can be poured; (2) the nature of the mould material had to be such that no gases are formed during contact with the molten metal until this has set; and (3) the mould surfaces had to be sufficiently strong to resist the cutting action of the molten metal.

Problem of Rate of Heat Removal

The vital point is the rate of removal of heat from the molten metal. This rate of removal of the heat until the molten metal has completely set depends upon the heat-resisting qualities of the material, the temperature of the molten metal, and quantity of metal involved, as well as the

Eight machines, having a capacity of 40 tons per eight-hour day, are in use at the plant of the Holley Carburettor Co. The floor space occupied is 2,700 sq. ft.

After a very thorough investigation by the Franklin Institute of Pennsylvania, the Edward Longstreth medal was awarded to Mr. Daniel H. Meloche of the Holley Carburettor Co. for

his invention of the process which made the long-life mould a commercial success. The Franklin Institute has been in existence since 1824, and, it is said, has never made an award for an invention that afterwards failed of its purpose. Awards are made on basic patents only. In this case the award was based on United States patents 1,453,593-1,492,694-1,506,130.

Seamless Cylinders for Compressed Gases

(From a Correspondent)

It is generally accepted that the immunity from accidents, with which British-made gas cylinders are favoured, is due to the fact that the seamless cylinder is now a recognised type, and that great care is taken during manufacture, by careful inspection and test at every stage. Recent developments in high pressure installations seem to indicate that much more reliance can be placed upon steel vessels than hitherto. It seems strange, however, that for many years gas cylinders have been handled and transported, when the contents of the container exert such a high pressure as 1,800 lb. per square inch. Many millions of cubic feet of compressed gas are used annually, so that a short summary of the information available in connection with this industry may be of general interest.

Many improvements in the manufacture of gas cylinders have been brought about in recent years, and seamless cylinders are now being made having a diameter of 24 in. Such large cylinders, however, are not being used for transport of compressed gas, but are for the storage of gas, as in the case of a Diesel engine air vessel.

Method of Manufacture

The general method of manufacture of a seamless cylinder is practically the same no matter what the size of the product may be. The importance of careful selection of the raw material cannot be over-emphasised, as the steel intended for the manufacture of gas cylinders must satisfy the requirements of a specially prepared specification. The blooms are cut into billets of required weight, and charged into a furnace, where they are heated to a temperature of approximately 1,250° C. They are then pierced in a hydraulic press, giving a solid ended hollow blank of circular section. Hot drawing and cold drawing operations take place, until a smooth shell of definite dimensions is obtained. Inspection for wall thickness and general surface follows, and the cylinders are then ready for the "necking operation." The cylinders must be subjected to special heat treatment, and prepared for hydraulic testing, after which they are dried out and made ready for filling.

There are many specifications to which cylinders may be made, depending upon the nature of the gas, working pressure, and other variables. The Home Office Recommendations of 1895, republished 1903, are for cylinders for a maximum working pressure of 1,800 lb. per square inch and a test pressure of 3,360 lb. per square inch, and were drawn up at a time when the properties of steel were not too well known. The stress in the walls of the cylinder, under working pressure, must not exceed 8 tons per square inch, and the steel suggested has a maximum carbon content of 0.25 per cent. and a total iron content not less than 99 per cent. Cylinders to these recommendations are very suitable for such gases as air, oxygen, hydrogen, carbon dioxide and nitrous oxide.

Report of Gas Cylinders Research Committee

The Gas Cylinders Research Committee published its first report in 1921, which report, however, is concerned exclusively with cylinders for the storage of those gases which are generally known as "permanent gases," such as air, oxygen, nitrogen, and hydrogen. These cylinders are not accepted when full of gas for rail transport. They are designed for a working pressure of 1,800 lb. per square inch, 3,000 lb. per square inch test pressure, and a wall stress at working pressure of not more than 10 tons per square inch. The chemical composition of the steel allows a carbon content of between 0.43 per cent. and 0.48 per cent. It will be obvious that

cylinders to these later recommendations will be lighter, resulting in cheaper transport charges of the compressed gas.

Acetylene cylinders are also made to stringent recommendations, although this gas is supplied at a much lower pressure. Its explosive nature, however, calls for special consideration. Anhydrous ammonia is used a great deal in connection with refrigerating plant. It must not be confused with household ammonia, which is merely a solution of ammonia gas in water. Perhaps the largest ammonia containers are those having a water capacity of 200 lb., or an ammonia capacity of 100 lb., as the cylinders are designed to carry $\frac{1}{2}$ lb. of ammonia per lb. of water capacity. These large cylinders have an overall length about 7 ft., and a diameter about 10 in. The test pressure is usually 100 atmospheres, or 1,500 lb. per square inch, so that the shell thickness of an ammonia cylinder will be less than that of an oxygen cylinder of the same diameter.

Nitrous oxide cylinders are not large, and cylinders for 1,000 gallons are about 5 in. in diameter and approximately 4 ft. in length. A very convenient size for the dentist is the 100 gallons size, having a diameter of 3½ in. and a length of 1 ft. Another gas of considerable commercial value is carbon dioxide, which gas may exert a pressure of 2,000 lb. per square inch. The cylinders, however, may or may not be fitted with a safety disc valve which releases the gas, should the pressure exceed a definite amount. Sulphur dioxide, chlorine, and phosgene are transported in special containers.

An attempt has been made to distinguish various cylinders by a colour scheme, and one can readily distinguish a cylinder of hydrogen from one of oxygen by the red colour of the hydrogen cylinder and the black colour of the oxygen cylinder, whilst the valve fittings for these are also different.

Hundreds of thousands of cylinders are in daily use. Replacements are necessary as a result of internal corrosion causing loss of wall thickness and suspected weakness, so that cylinders are constantly being made in large numbers.

Metallurgy in South Wales

For hundreds of years South Wales has enjoyed a high reputation for skill in metallurgical operations. Swansea was long known as "Copperopolis," and is still an important centre for copper working, although the actual smelting is now principally done abroad. Instead, Swansea has developed in the tinplate and galvanised sheet industries and the oil trade, while in later years the manufacture of nickel alloys built up on the nickel trade has become of world-wide importance. An enormous trade is being done in nickel alloy for motor radiators. In another way South Wales is benefiting from the growth of the automobile, as special steel, under the name of "Stalloy," manufactured only at Newport, is being increasingly used for motor car bodies.

Death of Ex-Managing Director of Hadfields

MR. ALEXANDER M. JACK, who died in a Sheffield nursing home on Tuesday, was made C.B.E. for national services during the war period, when he was managing director and deputy chairman of Hadfields, Ltd., whose output of munitions of war was very extensive. Mr. Jack, as a young man, served as an engineer in the United States Navy, following an apprenticeship at Woolwich Arsenal. He lived for a number of years in China, and was responsible for the erection of China's first modern arsenal near Tientsin.

Metallurgical Topics: Monthly Notes and Comments

From Our Own Correspondents

Autumn Meeting of the Institute

THE autumn meeting of the Institute of Metals will be held at Derby, September 6 to 9, under the direction of Sir Henry Fowler, vice-president, and with the assistance of Mr. G. W. Woolliscroft, Wh.Sc., M.I.Mech.E., who will act as honorary local secretary. The sixth autumn lecture will be delivered on Tuesday, September 6, by Dr. L. Aitchison, who will take as his subject "Non-Ferrous Metals in Modern Transport." On Wednesday, September 7, the general meeting will be held. The rest of the meeting will be taken up with the discussion of papers (which will be presented in abstract), visits to various works, and social activities.

Papers to be Read

THE following papers are expected to be submitted: Cook, W. T., and W. R. D. Jones, "The Copper-Magnesium Alloys. Part II"; Hume-Rothery, W., "Researches on Intermetallic Compounds. VI. The Reaction between Solid Magnesium and Liquid Tin"; Meissner, K. L., "Age-Hardening Tests with Elektron Alloys"; Raper, A. R., "The Equilibrium Diagram of Copper-Tin Alloys containing from 10 to 25 per cent. of Tin"; Smith, Cyril S., "Note on Cathodic Disintegration as a Method of Etching Specimens for Metallography"; Sutton, H., and A. J. Sidery, "The Protection of Aluminium and its Alloys against Corrosion"; Sutton, H., and J. W. W. Willstrop, "The Nature of the Film Produced by Anodic Oxidation of Aluminium"; Smithells, C. J., W. R. Pitkin and J. W. Avery, "Grain Growth in Compressed Metal Powder"; Gayler, Marie L. V., "The Undercooling of Some Aluminium Alloys"; Gwyer, A. G. C., and H. W. L. Phillips, "The Constitution of Alloys of Aluminium with Silicon and Iron"; Hargreaves, F., "Effect of Work and Annealing on the Lead-Tin Eutectic"; Hume-Rothery, W., and S. W. Rowell, "The System Magnesium-Cadmium"; Jenkins, C. H. M., "The Constitution and Physical Properties of Some of the Alloys of Copper, Zinc and Cadmium." Visits will be paid to the L.M.S. works; Derby Crown China Works; Rolls-Royce, Ltd.; Leys Malleable Castings, Ltd.; and the printing works of W. Bemrose and Sons, Ltd.

Coke "Reactivity" in Cupola Practice

WITH the exception of the paper read by Professor Desch, on stresses in non-ferrous castings, the generality of the papers read at the recent convention at Sheffield, although of fair general utility, were not of a very highly scientific order. Perhaps the most interesting was the American exchange paper dealing with the properties of coke, and their influence in the cupola melting of steel. It raised the now familiar question of coke reactivity, which is still a controversial subject amongst blast furnace men, and may become so amongst foundry men fond of academical discussions. The practical man has yet to be convinced in regard to the part played by coke "reactivity" in the absorption of carbon in cupola melting. No one will, however, dispute Mr. James Mackenzie's main thesis, that in the cupola reactions the structure of coke is of greater importance than its composition. Soft varieties gave the highest carburisation. It is evident that in the carburisation of iron in the cupola something more than temperature, time, and intimacy of contact are concerned. The factors are as numerous as those operating in the blast furnace, and probably less under control, for there will be, generally speaking, a greater uniformity of product in proportion to the greater mass of materials, in the blast furnace than in the cupola, where the time element as well is not of the same order.

Conflicting Requirements

IN Mr. Mackenzie's experiments, small charges of mild steel scrap were used, together with ferrosilicon and ferromanganese. High ash in the coke was found to play a very important part, evidently by (so to speak) smothering the molten metal and preventing proper contact between the fuel and the iron. A low ash coke is obviously indicated, and Mr. Mackenzie says it should not be too dense, and not be too porous; not too hard and not too soft; neither very heavy nor very light. This is not very informative, and something more constructive may be hoped for yet. Each kind of coke

seems to impart a definite carbon content to the iron, other factors remaining constant. This is tangible and interesting, but, with only a "carbon equilibrium" curve to guide us, and the knowledge that in theory this equilibrium should itself be a constant, but that in practice it is not so, seems to throw more onus on coke and its mysterious reactivity than plain circumstances warrant. The paper is an interesting one if only in so far as it shows clearly how very empirical our knowledge of coke really is, and what an enormous amount of research work will have to be done before the obscure property known as reactivity can really be understood.

Nickel and Chromium in Cast Iron

PROFESSOR PIWOWARSKY, of Aachen, read a paper at the Convention on the effect of nickel and chromium on grey cast iron. Several series of tests were made with high carbon-low silicon, and low carbon-high silicon iron, with and without chromium, and with and without chromium plus nickel. Oil-fired crucible furnaces were employed, and the melts were run into preheated chills, the aim being rapid but controlled solidification to yield white iron, with subsequent annealing and the production of fine graphite particles and a sorbitic structure. In some of these alloys very great tensile strength was developed, up to as much as 47 tons per sq. in. The elongation was moderate and the Brinell hardness high, but the machining qualities of the alloy metals were exceptionally good. The research work described opens a new vista of malleable iron alloys, which should find important uses in industry. Low phosphorus iron was used, but experiments are in hand with phosphorus up to 0.3 per cent. It would be of interest to know how the strength of these irons is maintained at high temperatures, and whether their behaviour in regard to "creep" gives any indication as to their use for valve parts, etc., exposed to high temperatures plus varying stresses.

The Literature of Aluminium

ALUMINIUM is becoming endowed with an extraordinarily voluminous literature. Indeed, the number of books of first-rate importance which have been published on aluminium of late exceeds that devoted to any other metal, iron and steel not excepted. The two latest deal respectively with bauxite and with the working of aluminium. In the former (*Bauxite*, by C. S. Fox. London: Crosby, Lockwood and Son. 30s.) Mr. Cyril S. Fox, of the Geological Survey of India, gives not only a comprehensive account of the occurrence and working of bauxite deposits, and of the use of the mineral in the extraction of aluminium, but gives some very interesting details relating to the aluminium industry itself. Not much is known or published relating to this great industry, which is controlled, practically, by about five companies. The metallurgy of the metal, on the other hand, is the subject of a very large number of books. To those interested in that branch of technology, Mr. E. T. Painton's book on *The Working of Aluminium* (London: Chapman and Hall. 13s. 6d.) will be welcome, and will be found to be thoroughly practical and workmanlike. The metallurgist will soon be under the necessity of enlarging the accommodation of his bookshelves, or of instituting a special section to deal with the literature of this important metal.

Transparent Metal Films

THERE have recently been opportunities of viewing some very beautiful and eminently practical examples of the use of exceedingly thin metal films for artistic decorative effects. The process for rendering them available has been devised by Mr. S. Cowper-Coles, whose work on hot galvanising with zinc is so well known. It has, of course, long been remarked that very thin films of certain metals are translucent to transmitted light, and that the coloured light they transmit in such circumstances differs from the light they reflect. Thus thin silver films transmit bluish light; very thin gold leaf is greenish, etc. The process referred to deposits the metals in ultra-thin films on glass, and these films transmit the usual colour of the metal by reflected light. The gold-coated glass is quite transparent, transmitting a pleasing green light. In the result panes of glass coated by this method can be used as

window screens, and for other decorative purposes, and while the occupants of rooms lighted by such panes can see out, those on the exterior cannot see in. Other metals are said to lend themselves to the process, and effective decorative schemes can thus be built up. Gold films have been stated to transmit ultra-violet light, and experiments are believed to be in progress to ascertain to what extent this property may likewise be applied with advantage.

Platinum Price Fluctuations

PLATINUM prices have fallen very considerably of late, and the situation is somewhat obscure. Some promising undertakings in South Africa have failed to realise the expectations entertained of them, but, on the other hand, Russian supplies appear to be plentiful, and there is a suspicion that stocks exist which might further depress the market, if liberated. The Russian Government controls absolutely all sale operations in regard to the metal, and is scarcely likely to cause a further price fall by letting the metal flood the market. The present shortage in America might have been expected to cause a rise in the quotations for the metal, and the fact that it has not done so may be taken as indicative of the fact that, whatever the shortage may be, demand itself has fallen very greatly. Many American refiners favour the proposal to standardise and hall-mark platinum, but French refiners are said to be averse to such suggestions. In the meantime, a movement is on foot amongst producers in South Africa to refine their own "platinoids," on the ground that they are not adequately paid for the associated precious metals, but only for the platinum, when the concentrates are sold in the ordinary way to the refiners.

Iron and Steel Institute: Glasgow Programme

At the meeting of the Iron and Steel Institute which will be held in Glasgow from September 20 to 23, the following papers will be read and discussed (the meetings being held in the Royal Technical College):—"High Frequency Induction Melting," by D. F. Campbell; "Magnetic and other Changes concerned in the Temper-Brittleness of Nickel-Chromium Steels," by H. A. Dickie (Glasgow Royal Technical College); "The Influence of Cold Rolling and Subsequent Annealing on the Hardness of Mild Steel," by C. A. Edwards and K. Kuwada; "The Influence of Nickel and Silicon on an Iron-Carbon Alloy," by A. B. Everest, T. H. Turner, and D. Hanson; "The Effect of Varying Ash in the Coke on Blast Furnace Working," by C. S. Gill; "The Constitution of Silicon-Carbon-Iron Alloys and a New Theory of the Cast Irons," by D. Hanson; "The Work Hardening of Steel by Abrasion," by E. G. Herbert; "On the Quantitative Measurement of the Cutting Power of Cutlery," by K. Honda and K. Takahasi; "The Use of Silica Gel as a Medium for Drying Blast," by E. H. Lewis; "The Mechanism of Tempering of Steels," by T. Matsushita and K. Nagasawa; "The Economic and Social Development of the American Iron and Steel Industry," by T. W. Robinson; "The Behaviour of Mild Steel under Prolonged Stress at 300° C.," by W. Rosenhain (National Physical Laboratory) and D. Hanson; "A Testing Machine for Repeated Impact, and a Preliminary Investigation on the Effects of Repeated Impact on Lowmoor Iron," by J. H. Smith and F. V. Warnock; "The Solution of Carbon in a-Iron and its Precipitation," by J. H. Whiteley; "A Contribution to the Theory of the Blast Furnace Process," by F. Wüst.

At the technical meetings Mr. F. W. Harbord, president of the Institute, will take the chair. Arrangements have also been made for visits to 13 industrial establishments in Glasgow and the West of Scotland.

The Advancing Use of Nickel

At the recent annual meeting of the Mond Nickel Co., Sir Alfred Mond made some interesting remarks on the growing importance of nickel. The deliveries of the company during the last financial year exceeded those of any previous year. Their deliveries appeared to be on an uprising scale, which, if no untoward circumstances arose, would, during the next financial year, enable them even to exceed the period just concluded. They were obtaining a surer footing in the United States, where deliveries last year were over double what they were two years before. The deputy chairman told them last year that they had reorganised their research

and development department. The work of that department had become an increasingly essential side of the company's activities. The march of engineering progress had now brought designers of machinery to a position where the materials previously available were no longer reliable, and they were looking about for additional alloys which would have the strength, combined with corrosion-resisting properties, necessary to meet the ever insistent demands for greater speeds, higher temperatures, and increased pressures. There seemed to be absolutely no doubt that nickel would form an essential constituent of almost every alloy which would meet those demands. Their research and development department was proceeding on a line of far-reaching investigation which, in the course of time, would become more and more valuable.

Protecting Aircraft Against Corrosion

A RECENT note from the United States Bureau of Standards states that one of the greatest drawbacks in constructing aeroplanes and airships from the light, strong, aluminium alloy, duralumin, is the fact that on exposure, especially to salt air, the alloy, particularly when in sheet or other thin forms, may become brittle through a type of corrosion which is not apparent on the surface and which therefore cannot be detected upon inspection. This sort of corrosion weakens the bond between the crystal grains that make up the alloy, and so is termed "intercrystalline embrittlement." The tiny, submicroscopic particles which give the alloy its desirable properties tend to collect at the grain boundaries. If this collection at the boundaries can be avoided, the tendency toward embrittlement is reduced.

In commercial practice the alloy is generally heated in a bath of fused salts (nitrates) and quenched for heat-treatment in boiling water; boiling water being used because the adhering salt is more readily dissolved than in cold water. On the other hand, the greater speed of quenching in cold water minimises the time for collection of the hard particles at the grain boundaries and hence markedly increases the resistance to intercrystalline corrosion. Work of the past two years at the bureau in co-operation with the [U.S.] Navy, Army, and National Advisory Committee for Aeronautics has shown that in laboratory corrosion tests duralumin quenched in cold water is markedly superior to that quenched in hot water or oil, but even this does not fully solve the problem, and protection of the surface of the duralumin is also advisable.

The Use of Protective Coatings

MANY types of protective coatings have been tried, several of which appear quite effective. Few coatings of the paint or varnish type, however, are completely impervious to moisture and most of them tend to crack or blister with age, thus losing their adhesion and some of their protective power. However, commercially pure aluminium is not subject to intercrystalline embrittlement because it does not contain the hardening particles that tend to create a pathway for the intercrystalline attack.

Hence, if an adherent coating of unalloyed aluminium be provided over the duralumin, good protection is afforded. This idea, evolved at the bureau some three years ago, was tried out in laboratory tests. Duralumin so protected proved superior to that protected in other ways because the aluminium coating will stand more scratching without laying bare the duralumin. Specimens coated with aluminium by the metal-spray process have been exposed to salt air for a year without deterioration.

It is interesting to note that one of the chief producers of duralumin has, by independent laboratory tests, corroborated the bureau's experience as to the good performance of aluminium-coated duralumin in resistance to corrosion, and is just starting to make commercially available duralumin in sheets coated with aluminium by a process which the manufacturer has worked out but which has not yet been described in detail. The product is of the same general type, however, as that which the bureau has tested extensively.

It therefore appears that by cold water quenching, by the use of aluminium coatings, and by the use of various protective films, varnishes, grease coatings, etc., as a further insurance against corrosion, the greatest drawback to long life and safety of duralumin for aircraft construction may be almost completely eliminated, and by means that are commercially practical.

Trade, Commerce, Finance: The Month in Review

From Our Northern Correspondent

THE month of July has not brought about any improvement in the condition of the iron and steel trade, although this is not surprising in view of the effect which the holiday season has on trade in general. One could hardly expect a revival in trade to commence at this time of the year, but it is a very unpleasant time for the steel works, which are now feeling in a marked degree the shortage of orders. This falling-off is reducing the number of furnaces and mills in operation, and outputs generally are down. There is now very little left of the accumulated orders from the strike period, and all the works are able to give almost immediate delivery of any orders placed with them. Here and there one finds some department busy on special work.

A Flat Market

The tone of the market is flat, and while this condition is more or less seasonal, it is nevertheless a source of anxiety to those who are responsible for the carrying on of the great works. What is still worse is the fact that there is really nothing to warrant any hope of a permanent improvement. There will certainly be a slight move in the autumn; there always is. That movement, however, is not likely to be very great. Those who study the tendencies of the iron and steel trade are being forced to the conclusion that the half-occupied, semi-depressed state to which we have been accustomed during the past few years is really the normal condition of the trade so long as the present plants are operating. It is not a cheerful view, but it is nearer the truth than the misguided reports which appear frequently in the Press to the effect that all is right with our trade and that we may soon expect prosperous times. That forecast cannot, and does not, apply to the iron and steel trade, and the sooner that fact is realised, with all its implications, the sooner shall we get down to the remedy.

It is not healthy—rather is it decidedly unhealthy—for any trade to find itself faced with partial, uneconomical operation, relief from which can only be obtained by means of industrial or international conflict. That is the present outlook, as it has been the past experience, of the iron and steel trade, and there appears to be nothing else to hope for until some of the works give up the struggle and so reduce the number of plants waiting to be fed. As conditions are now shaping themselves, we are heading for the time when breaking point may be reached.

The Price Problem

Such an eventuality is foreseen by many of the leaders of the industry, and that is the reason for the continued existence of the price associations and the adherence of the members to the prices fixed. There has been a notable laxity in this respect in connection with most associations, and evasions of the prices and regulations have been all too common. Such a practice, if allowed to continue, can end in only one thing—the disruption of the associations and the substitution of a further period of intense price cutting. Recently it has been noticeable that quotations for all kinds of steel have adhered closely to the association limits, and there is evidently a determined effort being made to maintain these prices. They are not profitable prices, and every cut in them makes the position worse for the steel makers.

The danger is plain to those who are anxious for the welfare of the industry, but sheer necessity may yet defy them and compel the abandonment of fixed prices, so that the works may be free to get the orders they so much need to keep the plant in operation. It is hard to determine which is the better plan, to keep the associations in being and so extend this period of partial operation, or to allow unrestricted competition. Both mean loss to the industry, but the latter would bring matters to a head, and would eliminate those works which are least fitted to carry on the fight. Then with a productive capacity more in accord with the needs of the country we might hope for a more economical activity in the trade, such as we were accustomed to before the war. It must be realised that the trade is not there to keep all the post-war plants busy, and as success does not attend the efforts to create the trade, the situation will have to be faced from the other angle and the question of excess capacity will have to be tackled.

The attempt to foster trade in this country by means of the Safeguarding of Industries Act failed. The next move has been the application under the Merchandise Marks Act, and this seems to have achieved some measure of success. The committee before whom the matter has been ventilated have decided to recommend that a Sale Order be granted. The goods to which the order, if granted, will apply are plates and sheets, rails and joists, sections and bars. The applicants wanted an Importation Order which would have ensured the marking of the goods on arrival into the country, but the committee would not consent to this. The sale order means that the goods will not need to be marked unless and until they are sold or exposed for sale in this country. If they are imported direct by the user, they need not be marked.

Effect of a Sale Order

The only people who will be affected by the order are the merchants, through whom a large proportion of the foreign steel is bought. It is difficult to see what help this will give to the steel trade here. It may be that some of the steel supplied by merchants has been bought by consumers under the impression that it is British steel, but, generally speaking, the buyer knows that he is getting foreign steel, and the marking of it will not trouble him. It is notorious that the small steel bar trade in this country is suffering very severely from continental competition, and large quantities of foreign bars are being used here, particularly in the Midlands, at prices with which the home works cannot compete. There will be no alleviation of this hardship as a result of the new order. An importation order might have been more effective, although the use of foreign steel is now so widespread that mere marking is not likely to disturb it. So long as foreign semi-finished steel is allowed to come in free, a half-hearted attempt to put a check on the sale of finished steel from abroad is of little use.

The Steel Makers' Policy

The steel makers themselves are trying another scheme to prevent the importation of foreign steel plates for shipbuilding. The proposal, briefly, is to grant a rebate in price to the shipbuilders on condition that they buy all their plates from the home works. The rebate is graded according to the quality contracted for. That is certainly a more effective way of checking foreign competition; but unfortunately it means cutting a price which is already too bare. However, if the rebate is sufficient to bridge the gap between home and foreign prices, it may mean more orders for the plate mills with increased outputs and lower costs. The next move will be on the part of the foreign works, who will not give up this trade without a fight.

The Month's Markets

Market conditions during the month have not presented any noticeable features. Pig iron is very weak and the reductions in price have brought out no more business. Northamptonshire foundry iron can now be bought at 6s. 6d. and Derbyshire iron at 6s. to 6s. 6d. at the furnaces. It is probable that if orders are not forthcoming at these prices, furnaces will be damped down rather than make further reductions. Hematite iron has also fallen considerably, and the makers are disposed to damp down the furnaces rather than accept lower prices. There has been rather more buying of hematite recently, as there is a feeling that the price has reached bottom.

Finished steel prices remain unchanged as far as they are within the scope of the associations. Plates remain at £8 7s. 6d. basis, and sections at £7 12s. 6d. For any classes of steel outside the associations there is keen competition, and very low prices are being quoted by the works who are short of orders. Billet prices have fallen and are now back at the pre-strike level. At the moment there is a slight falling-off in the amount of semi-finished steel imported from the Continent.

The production of pig iron in June amounted to 650,500 tons, compared with 720,100 tons in May. There were nine fewer furnaces in blast at the end of the month than at the beginning. The production of steel ingots and castings was 747,300 tons, compared with 884,600 tons in May.

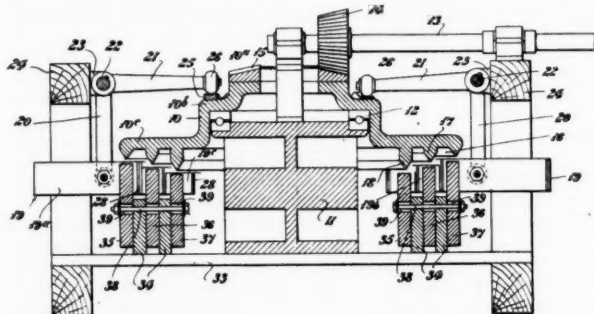
Some Inventions of the Month

By Our Patents Correspondent

Abstracts of other Patents of metallurgical interest will be found in our Patent Literature published weekly in THE CHEMICAL AGE.

Magnetic Separators

A MAGNETIC separator for ores is provided, as its essential feature, with a horizontal conveyor operating between upper and lower magnets, the conveyor being stepped so as to form a plurality of surfaces at different levels, and which always maintain a horizontal position. The figure shows one form of apparatus. The magnet 10 is supported on the magnet core 11 by the bearing 12, and is driven through the bevel and crown wheels 14 and 15; it is provided with three concentric depending rings 16, 17, 18, which serve as the magnet



271,924

points and as the take-off means for the separated material which is conveyed transversely beneath them by the diametrically opposed stepped conveyors 19. The latter, of the shaking type, are operated from a cam surface 25 on the rotating magnet 10 through the bell cranks 21 pivoted at 22. The lower fixed magnet points 35, 36, 37 are arranged so as to be adjustable to any height desired according to the nature of the separation to be effected. In a modification the upper magnets are also fixed, the separated material being removed by means of belts passing beneath the upper magnet points. See Patent No. 271,924, by A. Davies, London, having the date January 28, 1926.

Alloys

A NUMBER of patents and patent applications relating to the composition of alloys continue to appear. Thus in Patent No. 272,320 S. Beckinsale and H. Waterhouse, of the Royal Arsenal, Woolwich, find that an addition of cadmium to lead in conjunction with up to 5 per cent. of tin or up to 3 per cent. of antimony, is beneficial; such alloys can be further improved by heating to 150° C. and quenching and, compared with pure lead, are less liable to fail by intercrystalline disintegration under the action of alternating stresses. K. Schmidt, of Neckarsulm, Württemberg, Germany, in Patent No. 272,972 describes a series of aluminium alloys containing 0.1 to 4 per cent. of manganese, 0.5 to 6 per cent. of antimony, and 0.1 to 10 per cent. of magnesium; by the action of corroding agents there is formed a coating which resists further corrosion. In Patent Application 270,640 A. Kropf, of Wetzlar-on-Lahn, Germany, describes alloys of high melting point which contain 1 to 40 per cent. of chromium, 1 to 40 per cent. of tantalum, 10 to 60 per cent. of tungsten, 5 to 30 per cent. of molybdenum, and 0.5 to 4 per cent. of carbon.

Rust Proofing Iron

THE rust proofing of iron articles by the formation of a layer of insoluble phosphates thereon is effected by the use of solutions of the crystallised dihydrogen ortho phosphates of iron, zinc, manganese, or cadmium, the preparation of which is described in Specification No. 270,820 (see THE CHEMICAL AGE, Vol. XVI, p. 604). Such solutions are found to have a greater rust-proofing action (based on the amount of phosphoric acid present) than the baths hitherto proposed, such as the solutions obtained directly by dissolving the metals in phosphoric acid. See Patent No. 273,168, by the Parker Rust Proof Co., Detroit, U.S.A., having the date February 16, 1926.

Lead and Zinc

ACCORDING to a patent by W. H. Corbould, Sydney, N.S.W., Australia, lead and zinc are separated from materials containing their oxides by solution in acetic acid, followed by precipitation of the lead as lead sulphite by means of sulphur dioxide. The lead sulphite is roasted to obtain the oxide which is reduced in the usual manner. The solution is then either purified, neutralised, and electrolysed for separation of zinc, or is treated with sulphuretted hydrogen to precipitate the zinc as sulphide, which is roasted, etc., in the usual way; the zinc may also be precipitated as hydrate together with impurities, the zinc hydrate then being purified by solution in ammonia, filtration, and reprecipitation by injection of steam. The residual solutions, which contain acetates of calcium, barium, etc., are treated with sulphuric acid for recovery of acetic acid, calcium, etc., sulphate being precipitated; any excess of sulphuric acid is removed by addition of a little lead acetate. See Patent No. 273,420, having the date April 13, 1926.

According to a patent by H. Harris, London, mixtures of sodium arsenate, stannate, and antimonate such as are obtained by the process described in Specifications 213,638 (see THE CHEMICAL AGE, Vol. X, p. 495) and 245,479, are treated with cold caustic soda solution containing about 100 to 250 grams of caustic soda per litre; the sodium stannate passes entirely into solution together with a very little sodium arsenate, and the solution may be treated for recovery of tin, for example, by electrolysis. The residue may be worked up for production of pure sodium arsenate.

Magnesium, etc.

G. MICHEL, Bagneux, Paris, finds that an atmosphere of sulphur dioxide is very suitable for preventing the oxidation of molten readily oxidisable metals such as magnesium, calcium and aluminium; the gas may be introduced into crucibles in which the metals are being melted or into electrolytic tanks in which they are being produced. Sulphur dioxide can also be used for extinguishing ignited metal. See Patent application 271,088, having the International Convention date May 11, 1926.

Electrolytic Methods

ACCORDING to Patent Application 271,521, by Berzelius Metallhütten Ges., Duisberg, Germany, and having the International Convention date May 21, 1926, metals to be refined electrolytically are employed in the form of very thin sheets or as chips or granules. Iron wire baskets may be used to contain the anode material. It is stated that interference due to the accumulation of residual metals on the anode is avoided. The method is particularly applicable to the refining of tin containing more than 20 per cent. of other metals and of copper alloys containing less than 98 per cent. of that metal.

Copper

ACCORDING to the Copper Deoxidation Corporation, New York, U.S.A., copper is maintained, during refining and casting, out of contact with combustion gas. Various methods of desulphurising, deoxidising, etc., are described. See Patent Application No. 271,853, having the International Convention date May 26, 1926.

Manganese Steel for Wearing Parts

WEARING parts for stone breaking and ore crushing machinery in Hadfields' patent manganese steel and other special steels form the subject of a brochure issued by Hadfields, Ltd. "Era" steel (in addition to many other valuable properties) is claimed to be unequalled for resistance to abrasive action, while its strength reduces breakages to a minimum. There are notes on the use of "Era" manganese steel in jaw faces; crusher jaws; cheek plates, toggles and toggle bearings; mantles and concaves; crusher roll shells; crushing discs; runner rings and bottom plates and other wearing parts of ball and tube mills; perforated screen plates; mortar box liners for stamper crushing machinery, etc. The "Hecla" steel is used in forged steel eccentrics and other kinds of shafts for crushing machines of all types, forged steel shoes and dies, disc crushers, etc. The "Era," "Hecla," and other steels also find many other applications.

Current Articles Worth Noting

We give below a brief index to current articles in the technical Press dealing with metallurgical subjects.

ALLOYS.—Aluminium bronze. J. Strauss. *Trans. Amer. Soc. Steel Treating*, July, pp. 69-105. A review of the constitution, mechanical properties, and resistance to corrosion of these aluminium-copper alloys with and without the addition of other elements.

The industrial utilisation of aluminium alloys. H. Pommerenke and P. Herman. *Rev. Métallurgie*, June, pp. 297-306 (in French).

The anodic behaviour of copper-antimony alloys. H. Newmark. *Metall u. Erz.*, July 1, pp. 305-311 (in German).

Study of the velocity of solution of ultra-light alloys of magnesium. A. Portevin and E. Pretet. *Comptes Rendus*, July 11, pp. 125-127 (in French).

CORROSION.—The rusting of steel surfaces in contact. G. H. Tomlinson. *Proc. Roy. Soc. A.*, July 1, pp. 456-471.

Acid resistance of vacuum melted alloys containing nickel. W. Rohn. *Chem. Met. Eng.*, July, pp. 417-420.

GENERAL.—Properties of nickel and nickel-chrome steels. *Nature*, July 23, pp. 134-135.

Practical application of inhibitors in pickling operations. F. N. Speller and E. L. Chappell. *Chem. Met. Eng.*, July, pp. 421-423.

The phenomena of electrolytic crystallisation. I. V. Kohlschütter. II. The forms of aggregation of loose metallic precipitates. V. Kohlschütter and A. Good. III. The formation and properties of cohesive metallic layers. V. Kohlschütter and F. Jakober. *Z. Elektrochem.*, July, pp. 272-277, 277-289, 289-308 (in German).

Contribution to the knowledge of the ternary system copper-aluminium-manganese and its magnetic properties. W. Krings and W. Astmann. *Z. anorg. u. allg. Chem.*, Vol. 168 (1 and 2), June 28, pp. 145-164 (in German).

On the desilverisation of lead. E. R. Thews. *Continental Met. Chem. Eng.*, June, pp. 165-168; July, pp. 199-201 (in English).

IRON AND STEEL.—Copper steel. Its resistance to corrosion. M. Grison and E. Lepage. *Rev. Métallurgie*, June, pp. 331-336 (in French).

Iron and steel internationally considered. Sir William J. Larke. *J. West of Scotland Iron and Steel Inst.*, January, pp. 40-50.

New researches on the cementation of ferrous alloys by chromium and tungsten. J. Laissus. *Rev. Métallurgie*, June, pp. 345-352 (in French).

Iron-carbon-vanadium alloy for Brinell balls. G. W. Quick and L. Jordan. *Trans. Amer. Soc. Steel Treating*, July, pp. 3-26. A special iron-carbon-vanadium alloy of about 2.9 per cent. carbon and 13 per cent. vanadium has been experimentally used for Brinell balls in the testing of steels of such hardness as to cause ordinary Brinell balls to deform both elastically and plastically.

The effect of heat treatment on the combined carbon in gray cast iron. E. L. Roth. *Trans. Amer. Soc. Steel Treating*, July, pp. 27-40. Samples of two gray irons were examined. Maximum graphitic carbon was precipitated in both cases at 1,400° F. Graphitisation is propagated from the edges towards the centre. The silicon is believed not to have a marked effect on graphitisation. The degree of graphitisation does not increase with rising temperature.

A neglected phenomenon in heat treatment. B. Egeberg. *Trans. Amer. Soc. Steel Treating*, July, pp. 46-50. By quenching a piece of steel, in which there is a considerable difference between the Ac and Ar points, at a temperature close to the Ar point rather than the Ac point, the advantages of the lower quenching temperature are gained.

On the effect of nickel and chromium on the strength properties of gray cast iron. E. Piwowarsky. *Foundry Trade J.*, July 7, pp. 4-6; July 14, pp. 37-40.

The decomposition of the austenitic structure in steel. VI. Proposed theory for the hardening and tempering of steels. O. E. Harder and R. L. Dowdell. *Trans. Amer. Soc. Steel Treating*, July, pp. 51-68. The theory discusses the decomposition of the austenitic

structure, the reactions on heating steels above the critical points, the changes which take place while holding at temperature, those which occur at various rates of cooling and those which occur on reheating hardened steels to various temperatures below the critical for various lengths of time.

Determining the proportional limit of steel. B. Kjerrmann. *Trans. Amer. Soc. Steel Treating*, July, pp. 41-45.

PLATING.—Chromium plating—a new aid to industry. D. H. Killeffer. *Ind. Eng. Chem.*, July 1, pp. 773-776. Chromium (states the author) is now being electroplated commercially on many different metal bases. It is practically tarnish-proof and imparts this property to articles protected by it. Its hardness is considerably greater than that of cold-rolled steel, and it is capable of increasing the wear of parts subject to abrasion several fold. It resists nitric acid, air oxidation at high temperatures, salt water, sulphur compounds in petroleum, and a number of other corrosive agents. Although not a cure for all corrosion ills, it possesses merit under many conditions. Its cost is comparable with other electroplated protective coatings.

SINGLE METALS.—Vanadium. J. W. Marden and M. N. Rich. *Ind. Eng. Chem.*, July 1, pp. 786-788. Vanadium metal has been prepared. Contrary to previous statements in the literature, this metal is not like arsenic or bismuth. It is not brittle, but may be cold-worked into wire or other forms. Chemical analyses have been made of the vanadium samples and a number of physical properties, such as specific gravity, electrical conductivity, etc., have been determined. In properties vanadium resembles tantalum.

The crystal structure of α -manganese. A. J. Bradley and J. Thewlis. *Proc. Roy. Soc. A.*, July 1, pp. 456-471.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

[NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]

HEATH (ROBT.) AND LOW MOOR, LTD., Stoke-on-Trent, coal and iron masters. Registered July 11, charge by way of additional security (supplemental to £9,257 mortgage dated November 12, 1923), to Bank; charged on land at Sneyd Green, Stoke-on-Trent. *£1,071,766. July 28, 1926.

MONDEGO TIN DREDGING CO., LTD., London, E.C. Registered July 16, £1,000 debentures, part of £10,000; general charge. *£22,500. April 26, 1926.

MONDEGO TIN DREDGING CO., LTD., London, E.C. Registered July 1, £1,000 debentures part of £10,000; general charge. *£22,500. April 26, 1926.

PEASE AND PARTNERS, LTD., Darlington, coal and iron masters. Registered June 7, £1,500,000 debenture stock inclusive of £1,000,000 already registered (secured by Trust Deed dated June 3, 1927, supplemental to Trust Deed dated December 20, 1922), present issue £500,000 B debenture stock; general charge. *£1,743,761. June 7, 1927.

SHEEPBRIDGE COAL AND IRON CO., LTD., Chesterfield. Registered July 16, £300 and £500 debentures part of £750,000; general charge (except uncalled capital and certain property). *£582,350. October 12, 1926.

SOUTHERN FOUNDRIES (1926), LTD., Croydon. Registered July 7, £20,000 debentures; general charge.

Satisfactions

ASHTON VALE IRON CO., LTD., Bristol. Satisfaction registered June 29, £3,000, part of amount outstanding July 1, 1908.

BLAENAVON CO., LTD., ironmasters. Satisfaction registered June 17, £2,233, part of amount registered August 24, 1911.

Monthly Metallurgical Section

Published in the first issue of "The Chemical Age" each month.

NOTICE.—Communications relating to editorial matter for our Monthly Metallurgical Section should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Communications relating to advertisements and other business should be addressed to the Manager. Contributions will be welcomed from correspondents on any points of interest to metallurgists bearing on works practice or current research problems.

Chromium Plating of Metals

A Review of the Present Position

A great deal of confusion appears to exist with regard to the possibilities of chromium plating. We give below the main points of an article by Mr. D. H. Killeffer, published in "Industrial and Engineering Chemistry," in which the whole subject is carefully reviewed.

MUCH interest and not a little unnecessary mystery have centred lately around the electroplating of metallic chromium, a metal long known and long used in industrial alloys but only now commercially available as a pure metal. As long ago as 1854, Bunsen succeeded in electrodepositing chromium from solution, but nothing remotely approaching industrial application of this remarkably useful metal came into being until within a very few recent years. It is one thing to form an electroplate of chromium and quite another to make such a coating smooth, adherent, and commercially useful, as many failures in the past have clearly demonstrated.

Properties of Chromium

The properties of chromium which make it particularly useful to industry are its extreme hardness and resistance to abrasion, and its ability to withstand many of the ordinary agents of corrosion, including oxygen at high temperatures and superheated steam. Not only does the metal itself possess these properties to a remarkable degree, but a comparatively thin electroplate of it on an unresistant base metal imparts these properties to the combination to a useful extent. The hardness of chromium on Moh's mineralogical scale is stated as 9, which places it in the class of emery and far above any other known metal. It is harder than iridium and the hardest of steels. In electroplating it some variations in hardness are possible according to the conditions of plating, but it is easily possible to realise its full hardness in a plate.

Related to its hardness, but not necessarily inherent in it, is chromium's resistance to wear and abrasion. Even very thin films exhibit this property to a remarkable degree, and metal parts subjected to the destructive forces of sliding wear can have their lives increased many fold by protection with a chromium plate.

Resistance to Corrosion

Chromium is decidedly resistant to a variety of chemical reagents, but it is not a panacea for all ills. It is unaffected by the ordinary atmospheric agents of corrosion, and retains a brilliant finish although exposed to rain, snow, and sea water. It resists all ordinary acids except hydrochloric and sulphuric, and is unaffected by sulphur compounds generally, including hydrogen sulphide, sulphur dioxide, etc. It is not discoloured by heating in air up to 300° C. and resists physical breakdown by oxidation up to 1149° C. Its melting point is 1520° C.

Early chromium plates were unsatisfactory in their resistance to corrosion possibly because of the difficulty of making a firmly adherent plate free from pinholes, a condition obviated by recent improvements in methods of its application. The presence of pinholes is especially to be avoided in a plate on iron, as chromium is "nobler" than iron and its presence tends to increase the speed of electrolytic corrosion of iron with which it is in contact. In general, it is preferred for corrosion resistance to put the chromium on top of a nickel or copper plate to insure protection of the iron and complete adherence of the final protective coating.

Conditions of Plating

The method of application of chromium electroplates is subject to a wide difference in detail among the various operators. The general principle upon which all commercial baths are now based is the use of a hypothetical compound, chromium chromate. Every bath contains chromium in both the trivalent

and hexavalent forms and there is presumed to be a compound between these two. The plating operation consumes hexavalent chromium, and this must be constantly replaced. In addition, the bath usually contains an acid such as boric, sulphuric, phosphoric, or hydrofluoric, which is neutralised by part of the trivalent chromium present. Some operators add relatively small quantities of other materials to improve the throwing power of the bath. The bath originally used by the Bureau of Engraving and Printing contains CrO_3 , 250 grams; $\text{Cr}_2(\text{SO}_4)_3$, 3 grams; and $\text{Cr}_2\text{O}(\text{CO}_3)_2$, 7 grams, per litre. This is a representative bath.

Variations in the temperature of plating have a profound influence on the character of the result. From a warm solution a bright, smooth deposit of great hardness is obtained at a temperature of 40° C. or higher. This type of coating is too hard to be satisfactorily buffed, and must be applied to a smooth undercoating or to a smooth buffed piece of work. Several operators prefer to apply this smooth, bright coating, as it avoids finishing of the hard chromium layer, and the undercoating of copper may be buffed more easily to a smooth brightness. One operator prefers to plate from a cold bath (cooled by water coils), and to buff the resulting grey plate with abrasive.

The current consumption of this plating operation is disproportionately large because chromium must be reduced from a valence of six to a valence of zero and hydrogen is deposited at the cathode along with the metal. The various operators have preferred current densities which are not all in complete agreement, but generally range from 1.4 to 20 amperes per square decimetre on the cathode. At low current densities the cathode efficiency rapidly drops off and 4 to 5 amperes per square decimetre is considered by many to be the lowest practicable limit, although others operate considerably below these values.

The work is prepared for plating by several methods, depending largely on the use to which it is to be put and to some extent on the tastes of the plater. It is essential that the surface be smooth and clean, and this is ordinarily accomplished by buffing and electrolytic cleaning. For wear resistance, as on engravers' plates, bearings, etc., and for resistance to heat as on automobile valves and piping for cracking stills, the chromium is plated directly on steel. It is possible by careful cleaning to apply chromium directly upon cast iron, but this is not usual practice. Brass, copper, and nickel require no special preparation for plating beyond careful cleaning and buffing. It has been impossible so far to apply chromium to aluminium, but satisfactory coats have been obtained on duralumin. Satisfactory plates have been built up on invar. For corrosion resistance and for a specially brilliant result, copper is ordinarily applied underneath the chromium, and one operator prefers to put chromium on top of thin layers of both copper and nickel on steel work.

Applications

The original use of electroplated chromium was for decoration and resistance to atmospheric corrosion. For this purpose it was early applied to automobile parts ordinarily nickel-plated, and the increased life and resistance of the new metal have proved highly advantageous. Among its other valuable properties, chromium possesses a surface to which water will not easily adhere. Tarnishing of chromium

under ordinary conditions is quite impossible, and the only signs of use in service are actually on top of the surface and are not parts of it. This is in contrast to tarnish of most metals, which involves both the metal itself and surface accumulations. The practice of polishing tarnished nickel-plated articles with abrasives it is necessary to remove, not only the surface dirt, but also the oxide which forms a part of the surface after exposure. With chromium plates abrasives are quite unnecessary, as no oxide forms under ordinary exposure conditions, and the mere wiping of the surface with a moist cloth will remove surface accumulations.

Decorative chromium plates are used extensively on marine hardware—subject to severe corrosion by air and sea water—automobile parts, plumbing supplies, and mirrors. Less than one-tenth of a mil serves for ordinary decorative purposes, and usually this thin plate is applied over a buffed copper plate, as it is easier to finish the softer copper than to attempt to polish the chromium. Such a plate on an automobile radiator shell has been in service for more than four years without sign of failure or tarnish. By plating the chromium on a perfectly smooth surface an extremely brilliant result can be obtained. Mirrors for automobile headlights are thus finished, and although the mirror originally has only about three-fourths of the reflective power of silver, it retains this indefinitely. Such a mirror will continue in service without loss of brilliancy many times longer than will a silver or nickel-plated mirror.

Where comparatively high resistance to corrosion is required, as on automobile bumpers, radiator shells, etc., it is customary to cover steel with layers of either or both nickel and copper before putting on the finishing coat of chromium. In spite of using three separate platings, it is no more expensive to produce a finish by this method, which will withstand a 100-hour salt spray test, than by simple nickel-plating. If a much shorter salt spray test or none at all is required, nickel alone is somewhat more economical, but in general the greater brilliance of chromium plate over a longer period gives it the advantage. Plumbing fixtures made of brass and plated with chromium require no polishing, a feature which has a strong appeal not only to the careful housekeeper, but also to the managements of large hotels. Thicker coats than those above are required to resist this type of corrosion, but the resulting saving in polishing equalises the cost.

Resistance to perspiration makes chromium valuable as a decorative coating on such things as wrist watches, which might otherwise become tarnished, and its platinum-like colour has a strong appeal.

As Wear Resistant

The hardness of chromium, its resistance to abrasive wear, and its low coefficient of friction make it particularly valuable as a protection to bearings and machine parts subject to wear. An automobile engine provided with chromium bearings throughout has been operated for as long as two weeks without lubricant and without the destruction of the bearings which would be expected had they been made of case-hardened steel. Cams subject to both rolling and sliding wear have been successfully plated with chromium with greatly increased durability, and many of the small inaccessible machined parts in automobile engines have shown similarly lengthened service after plating.

Fine gauges, whose usefulness depends upon the constancy of their dimensions in use, can be made accurate over longer periods by giving them a surface protection of chromium to prevent the wear that would otherwise soon render them useless. Machine parts of other kinds where accuracy of dimension and hardness are essential can be machined somewhat smaller than the exact requirement, and the final finish given them by an accurately applied chromium plate. This not only leads to the recovery of parts accidentally machined beyond the limits of tolerance, but gives the parts a surface harder than any that can be secured by case-hardening, and avoids the hazards of dimensional changes in heat treatment.

Engravers' plates, used until they are actually worn out in the printing of currency and stamps by the Bureau of Engraving and Printing, are both difficult and expensive to make, and any increase in the service to be obtained from them is of importance. Chromium plating has been used to lengthen their lives to more than twice that of case-hardened steel and more than four times that of nickel plates.

The useful life of electrotypes can be similarly increased six to ten-fold.

The resistance of chromium to corrosion clearly points to definite applications in industry. It is useful in solving particular corrosion problems and, like other materials of a similar nature, it is not resistant to all corrosive agents. Chromium plating of piping and metal parts exposed to nitric acid, in its manufacture or use, materially increases their life. Sulphides, sulphites, and sulphur compounds so frequently met in industry scarcely affect it. Its life is much longer than iron or steel under such conditions and its cost is generally lower than that of the special alloy metals. The petroleum industry has found its combined resistance to oxidation by flue gases and to the sulphur compounds of petroleum of great value in protecting stills and piping.

The paper industry is finding chromium-plated equipment satisfactory in resisting the corrosive action of sulphite liquor and soda liquor in the kraft paper process. The moulds used in forming rubber articles in the vulcanisation process may be profitably made with chromium-plated surfaces on account of the resistance of these to corrosion by the sulphur compounds in the mix, and especially because the rubber dough does not wet, and stick to, the chromium as it does iron.

The cost of any kind of protection against corrosion is necessarily a ruling factor in any decision as to its final merit. Chromium plates ranging in thickness from 0.25 to 0.5 mil are considered satisfactory for most purposes, and within this range, and beyond, perfect coatings can be applied by methods now in use. The present cost of applying this protection varies rather widely, depending upon the character of the surface to be covered, but in general the cost of the operation on large quantity production is not more than double that of plating nickel and there is every prospect that this differential will be reduced as the newer art progresses.

The U.S. Patent Situation

Numerous patents cover the processes now in use in the United States for chromium plating, and it is impossible to make a fair exposition of this subject in view of apparent conflicts between some of these patents and the absence of any court decisions on the matter. The Chromium Corporation of America, a subsidiary of the Metals and Thermit Corporation, has a group of patents covering its processes, and is prepared to do a jobbing business in plating and to licence others to use them. The Chemical Treatment Co. merged into the Chromium Corporation of America some time ago. For some time the General Motors Corporation has operated a process for use in its manufactures, and has recently acquired some patents and has applications for others pending. These patents are operated by the corporation in its own works and are licensed to the manufacturers of automobile parts purchased by it.

The Metals Protection Co. of Indianapolis, an offshoot of the Haynes Stellite Corporation, owns a number of patents covering its processes, and is prepared to license users under them and to install equipment for chromium plating. This company has a commercial laboratory for developing specific uses for chromium plating and an engineering organisation for installing plants. The Bureau of Engraving and Printing at Washington is operating a process developed in the Bureau of Standards on the basis of Sargent's work, but has no patents on it. What the outcome of any litigation will be can only be surmised, and it is quite within the range of possibility that mutual licensing may prevent expensive legal proceedings.

World's Steel Output

ESTIMATES and returns of the world's steel production compiled in Germany indicate that the present year may be a record for output. One hundred million tons of steel may be the total for 1927, if the present figures are maintained. The record quantity hitherto is 87 million tons. British and American production, states the estimate, appears to have decreased since the first quarter of the year, the British falling off—according to the available figures for the second quarter—being from 2,507,100 tons to 2,482,000. German steel works, on the other hand, continued to expand in output. Their average for the months of April and May last was 1,311,100 tons, as compared with an average of 1,294,000 during the preceding three months. French average production by the month fluctuates from 658,000 to 688,000 tons.

Improvements in Ingot Casting

(FROM A CORRESPONDENT.)

THE methods in general use to-day for the casting of ingots of non-ferrous metals and alloys are not substantially different from those in use long ago. It is true that in many directions improvements have been made, such as the substitution of iron for stone moulds, and the provision of facilities for more rapid working, but no very fundamental changes have been introduced. Much defective material which is produced is due to inherent defects in the metal—that is, imperfections in or on the original ingots. In recent years attempts in many directions have been made to improve the soundness of ingots and their surface quality, with the object of reducing the amount of defective sheet, rod and tubing, etc., produced from them. Much more is now known, as a result of these efforts, of the influence on resulting ingots of such factors as pouring temperature and speed, and mould temperature. The number of different mould dressings in use is very large, and while many may possess minor advantages peculiar to themselves and in the particular circumstances in which they are employed, they all function fundamentally alike.

Splashing in the Mould

In the process of casting, one of the factors of greatest moment in connection with the production of good ingots is that of the splashing and turbulence of metal in the mould. In the ordinary way of top-casting there is no help for this, for the metal in the first instance falls in a stream from some six inches above the mould mouth to the bottom of the mould, which is quite frequently as much as, and more than, thirty-six inches long. Clearly the splashing and disturbance is greatest at the commencement of pouring and diminishes in extent as the mould is filled. Where the moulds are not provided with runner boxes it is very doubtful whether the metal reaches the bottom of the mould before striking one of the mould faces. Metal splashings often solidify on the mould walls above the metal level and, since the mould is comparatively cold, there solidify. As the metal level rises, and solidified splashings are covered, they may or may not be remelted. Where they have become coated with an oxide layer or film they cannot well be reabsorbed into the main body of metal, and thus in the finished ingot constitute a defect which very frequently remains undetected until subsequent working has proceeded to an advanced stage.

Turbulence within the mould also gives rise to the tendency to entrap carbonaceous material from the mould dressing, either between the metal and the mould face, giving rise to a bad surface, or within the ingot itself, producing internal defects. It is quite clear that any method of pouring or casting which succeeds in reducing the amount of turbulence and splashing will be conducive to reduction in amount of defects in and on the ingots and in material fashioned therefrom.

In casting, another factor of importance—and this applies with greater significance to metals and alloys which are readily oxidisable in the molten condition—is the oxidation which takes place between the metal leaving the crucible and its entering the mould. In normal pouring the stream of metal is comparatively narrow and small, and thus a very large surface is exposed to oxidising influences. This applies equally to methods of top and bottom pouring. In the case of aluminium bronze, an alloy which possesses many useful and desirable properties, and is superior in many respects to expensive straight tin bronzes, ordinary methods of pouring are not very successful, for the inclusion within the ingot of particles of alumina results in the mechanical properties of the metal being impaired, and also seriously interferes with the machining qualities. So much is this so that it is difficult and expensive to work the alloy into tubes and wire, for the hard particles cause a severe wearing action on the tools. In 1913 an apparatus was devised and patented by P. H. G. Deville whereby metals could be cast with the minimum amount of disturbance and the exposure of only a very limited surface of the melt to oxidising influences. This invention constituted the most notable innovation in casting practice made in recent years.

The Deville Method of Casting

In the first instance the method was applied to the casting of aluminium bronze alloys for coinage purposes, in order to overcome the inclusion of air bubbles, alumina, and other

foreign matter resulting from oxidation and turbulence during casting, but its use has extended, particularly in France, to other alloys. The apparatus employed, and which has proved quite successful, consists essentially of an ingot mould, a refractory lined ladle, and a refractory lined channel to connect ladle and mould. The three pieces are secured in a straight line, and the metal, at a temperature considerably above its normal pouring temperature, is transferred from the melting crucible to the ladle, where it is allowed to remain some little time and entangled foreign matter rises from the molten mass to the surface. This is skimmed off, leaving a comparatively clean surface, and the whole apparatus is rotated in a vertical plane so that the ladle ascends and the mould descends, the metal passing quietly from the ladle to the mould. The surface of the molten metal is thus always kept horizontal and there is no turbulence or splashing in the mould. This results in the production of ingots with excellent surfaces with an almost complete absence of defects, and further, internal defects are likewise substantially reduced.

In addition, therefore, to eliminating inclusions which make alloys of the aluminium bronze type difficult and expensive to machine, this method of casting reduces the amount of metal which has to be discarded and scrapped owing to defects. The process is, of course, not limited in its application to these alloys, and although especially designed to overcome difficulties encountered in the manufacture of material of this kind the method could be applied—and in some instances this has already been done—with beneficial results to other non-ferrous alloys, and possibly to steel also.

Pure Nickel for the Brewing Industries

THE question of the suitability of pure nickel for vessels such as storage and fermentation tanks as used in the brewing industry was recently investigated, and in order to arrive at a definite reliable conclusion practical trials were instituted in one of the largest Austrian breweries. It is stated that a small fermentation tank, as well as a small storage tank of about 50 gallons, were manufactured in pure nickel and introduced into the sequence of operations in a normal manner, the beer passed through these vessels and was finally filled into bottles as usual; it was afterwards examined and brewing experts declared the taste to be absolutely unimpaired, the colour a perfect golden yellow; in short the beer was absolutely normal in every way. The sample was then analysed for a possible nickel content, but a total absence of nickel or its compounds was established. This result of a practical trial would point to the suitability of nickel under working conditions. Nickel vessels of this type are made by the Berndorf Metal Works Arthur Krupp A.-G., who state that a large Austrian brewery has recently put into use eleven pure nickel fermentation tanks with a total capacity of 70,000 gallons. The agents of the Berndorf Metal Works of Great Britain are Messrs. R. Whitehead, of 86, Hatton Garden, London.

Platinum Metals in Canada

FINALLY revised statistics on the output of the metals of the platinum group, as reported by the Mining, Metallurgical, and Chemical Branch of the Dominion Bureau of Statistics at Ottawa, show that these precious metals were produced, in 1926, only in the provinces of British Columbia and Ontario. The total production of platinum being 9,521 fine oz., and of palladium, rhodium, etc., 10,024 fine oz. Canada, however, stands third in the world's production, larger amounts coming from Russia, and Colombia, South America. In British Columbia, small quantities are found in placer deposits with alluvial gold and black sands; in Ontario, these rare metals occur with the nickel-copper-sulphide ores of the Sudbury district. Copper-nickel matte containing the precious metals is made at Coniston by the Mond Nickel Co., Ltd., and at Copper Cliff by the International Nickel Co., Ltd. The Mond matte is shipped to Clydach, Wales, for refining; International matte is shipped either to the United States, for the manufacture into monel metal, or to Port Colborne, Ontario, for refining. When the copper and nickel are removed, the residues are further refined for the recovery of gold, silver, platinum, and palladium, with smaller amounts of rhodium and iridium.

Metallurgical Topics: Monthly Notes and Comments

From Our Own Correspondents

An Imperial Congress

THE second Empire Congress of Mining and Metallurgy, the sessions of which have just been concluded in Montreal, and which has reached the "visits and excursions" stage, is evidently going to be a very real success. The first of these Congresses was the one held at Wembley three years ago, the attendance at which was enormous. That the Empire is, in theory, self-sufficing so far as mineral wealth is concerned, is well known. What is required is to make it so in practice. We are still too greatly dependent on other nations for the actual supply of the needed industrial metals, seeing that the old home industries of making copper, zinc, and lead are slowly falling into desuetude. The fuel situation has, of course, much to do with the decay of the home manufacture of non-ferrous metals; that, and the absence of adequate water power. Yet water power is available in this country, and the latest of all the metal industries, that of aluminium, not only depends mainly upon water power, but is thriving and expanding. If it pays to import thousands of tons of bauxite and millions of tons of iron ore into this country, it should, in theory, pay to import far more copper, lead, tin, zinc, and antimony ores than are at present imported, while, from a "safety first" point of view, such a policy would seem to be imperatively needed. It is to be hoped that those responsible for the inception of the Empire Mining and Metallurgical Congress will do all they can to revive and foster the home industries as well as to develop and expand those of the outlying Dominions and frontiers of Empire.

Survey of Imperial Mineral Resources

THE survey of the Empire's mineral resources suggested by Sir Thomas Holland and adopted by the Montreal Congress is not a task that will be undertaken by the British Geological Survey, but by independent technical bodies in the Dominions. So far as the mineral areas of the Empire are concerned, the geological surveys are very inadequate. Statistics, on the other hand, only relate to production. They give no idea of the Empire's resources or reserves available for exploitation. The leading mining and metallurgical societies in the Dominions have done a certain amount of prospecting of special mineral groups, but no systematic survey of the whole resources of each territory has been undertaken. That is what it is now proposed to do. A general committee of experts will be set up in each Dominion or Colony, all the mineral areas will be mapped out, and a general reconnaissance made of the potential mineral wealth of each area. Among metals specially suggested for review are antimony, chromium, cobalt, manganese, mercury, nickel, tin, tungsten, and vanadium.

"It is not pretended," says Sir Thomas Holland, "that the British Empire can ever be independent and completely self-contained in mineral resources. The Empire, more nearly than any other national unit, possesses the variety of minerals required for modern industries, but of some essential minerals we could not produce enough to meet our peace time industrial requirements. The American assumption that they possess nearly full knowledge of the distribution of important mineral deposits may be approximately accurate for the United States, but it would be unwise to apply it to Canada, to our African Colonies, or to Australia. In any of these partially explored areas there may well be deposits large enough and rich enough seriously to divert the present stream of the metal trade. Even the new discoveries of manganese on the Gold Coast threaten to change the source of supply of these ores."

Unknown Possibilities

SIR THOMAS, who was formerly director of geological survey in India, quotes that great country as an example of the possibilities. Before the geological survey was organised, relatively lean iron ores were known to exist, and until about twenty years ago no one suspected the existence of the massive hæmatites covered by the jungles of Orissa and adjoining parts of Chota Nagpur. The reserves of ores (carrying an average of 60 per cent. of iron) are now estimated to run into several thousand million tons; and since the war, India has become an exporter of pig-iron even to the United States and to Great Britain. Ninety per cent. of the world's nickel

comes from a single district in Canada. Is it not possible, he asks, that the Canadian forests which cover much of the great crystalline complex, still hide more than one Sudbury? After the discovery of the Bushveld complex in the Transvaal, even Canada may not for long retain its monopoly.

There are also great mineral possibilities in Australia—especially Western Australia—as the Empire Marketing Board and the Development and Migration Committee realise, since they propose to "take a look over" that Dominion, prospecting for what was overlooked in the old days of the gold rush. In Southern Rhodesia, the chromite mining industry is only twenty years old, yet the output is now more than ten times that of New Caledonia, which was previously the chief source of that mineral. Nigeria and the Gold Coast, Kenya, Uganda, and Tanganyika are all potential sources of new mineral wealth; and with what Sir Thomas Holland calls "mineral watch committees" set up in each of the Dominions and Colonies, a great stocktaking of our mineral resources might reveal Empire riches that are now hardly even suspected.

Metallic Coatings

PROTECTIVE coatings are employed both for utilitarian and for artistic ends. That gold, hammered out to a degree of extreme tenuity, could be made to serve both purposes, appears to have been known for at least 7,000 years, and was employed for the covering of wood ages ago. "Rolled gold" is a familiar device of to-day, but it has not hitherto been found possible to devise any really satisfactory pigment having real gold powder as a base. Bessemer "gold paint" is, of course, not gold at all, but made from brass, and tarnishes and blackens very soon. A 10 per cent. aluminium alloy with copper wears better, but a really durable gold paint which will preserve its lustre is not as yet a commercial proposition, and gold leaf and gold plating by electro-deposition remain the only feasible modes of using gold as a protective coating. Silver foil is not used, for obvious reasons, and silver paint is invariably nowadays a paint with an aluminium base, preferably of high grade metal.

"Aluminium Bronze Powder"

ALUMINIUM bronze powder is a misnomer, as applied to the base of the silvery pigment with which we to-day paint our fences, gates and lamp-posts. The base is powdered aluminium, but trade terms die hard, and so, in common parlance, it remains "aluminium bronze" powder. As in all arts, the technology of the manufacture and preparation of the aluminium powder requires the utmost skill, care, and experience if the best results are to be obtained. The aluminium employed should be free from iron and from silicon, which not only make the metal hard and difficult to stamp, but detract from the silvery appearance of the powder. A few articles on the subject of the manufacture of aluminium powder and paint have been published from time to time in the technical papers. Now, it has a book to itself the latest addition to the Chemical Catalog Co.'s series being devoted wholly to the subject. (*Aluminium Bronze Powder and Aluminium Paint*, by Junius David Edwards, 12s. 6d. net.)

The Leafing of Aluminium Powder

THERE appear to be no reservations in Mr. Edwards' useful little book, wherein the whole art and mystery is fully revealed. He has much to say respecting the interesting property of "leafing," upon which much of the success of the operations depends. The flakes in the properly prepared powder measure 0.00007 in. in thickness, and in the best grades the ratio of area to thickness may be as high as 200 to 1. Ability to leaf is a property of polished powder only; it is influenced by the kind of polishing and by the medium employed, and may deteriorate by prolonged contact with a liquid or paint vehicle. The latter has to be chosen carefully. The industry of aluminium paint-making is one of steadily growing importance, and has its special technique, methods of testing, and specifications. The paint itself has remarkable properties of spread and opacity, and a high degree of corrosion-resistance. A curious point is referred to by Mr. Edwards. This is that smooth

glossy surfaces collect and hold more dirt than surfaces painted with a flat finish. Also, he states that aluminium paint collects less dirt than many white and light coloured paints, and that it washes relatively clean on exposure to rain. Evidently it is a most valuable adjunct in the protection of exposed surfaces, and this being the great *desideratum* of the day, those interested will welcome Mr. Edwards' useful little book.

Magnesium Resources

It is devoutly to be hoped that no considerations of a "vested interest" type will be allowed to stand in the way of the creation, before long, of a real magnesium industry in Great Britain. The metal is apt to be regarded as a rival to aluminium—as it undoubtedly is. Other countries are making marked progress, although, from motives of policy, no statistics of production are forthcoming. In America, for instance, these figures have been withheld for years, and no reliable estimates of either German or French production are available. The "magnesium sense" in this country is certainly undeveloped as yet. Hitherto the carnallite deposits of Strassfurt have been the main sources of magnesium on the Continent, but the fact that one of our own mandated territories contains untold wealth of magnesium resources has passed, practically, without comment. References to the magnesium chloride content of the waters of the Dead Sea, in Palestine, were made in an article on magnesium, which appeared in *THE CHEMICAL AGE* in November 7, 1925. A recent article in *The Times* of August 15 amplifies the particulars as to the resources of Palestine in magnesium salts. It is stated therein that the geologist of the Palestine Government estimates the amount of magnesium chloride present in the waters of the Dead Sea at 22,000 millions of tons, while the magnesium bromide salts are estimated at 980 millions of tons. It is proposed to evaporate the waters and recover the "carnallite" which will be marketed for the manufacture of "cotton goods, refractories, and cement compounds." If nothing more is done with the magnesium salts, this country will lose a great opportunity, which other countries are practically certain to recognise and to use to the fullest advantage. In the meantime, the amount of magnesium consumed in the United States doubled itself in the year 1925, while the price per pound for the ingot metal fell from \$1.07 to 86 cents per pound. Only about 4 tons of the metal was imported, as against 91 tons in 1922, while as 137 tons were consumed, it is not difficult, official reticence notwithstanding, to estimate the United States production as being within the neighbourhood of 130 tons per annum in 1925, and probably twice as much last year.

Nickel Tanks for Transporting Corrosive Liquids

WHAT is described as the first transport tank constructed entirely in malleable nickel in this country has recently been built for supply to a firm in Malaya for the transport of a liquid containing a small percentage of alkali. Tanks of iron, steel, or lead-lined steel were not permissible owing to the action of the liquor on the metal, with consequent effect on the purity of the liquor. Pure nickel was the only apparent solution of the problem. Even glass-lined tanks possessed the disadvantage that the lining might be cracked in transport, and also that the alkaline liquor might also have some solvent action on the glass lining. The tank is of 330 gallons capacity, and is built up entirely of welded malleable nickel plate, one-eighth inch in thickness. The butterfly nuts and bolts on the manhole are all of nickel, as is the run-off pipe, whilst a solid nickel valve was also subsequently fitted. The tank was mounted on hardwood bolsters with a cushion of Sorbo rubber strip to check vibration and shock. The chassis is a standard Morris 30 cwt. type, fitted with oversize tyres in order to reduce jolting as much as possible.

No Substitute for Manganese in Steel

In the manufacture of steel no satisfactory substitute for manganese is known, declares the United States Bureau of Mines. In Germany during the years 1917 and 1918, the shortage of manganese necessitated trial of many substitutes, such as aluminium in the form of silicon-aluminium alloys. Aluminium has a greater affinity for oxygen than manganese, but the oxidation of aluminium produces alumina, which is relatively infusible and often remains in the steel as slag inclusions. Aluminium cannot eliminate sulphur or change the condition of sulphur as manganese can. A slight excess of

aluminium tends to produce large pipes in the ingots. Silicon, in the form of ferrosilicon, probably has a greater affinity for oxygen than manganese, but its use is attended by the following disadvantages. In slight excess it causes large pipes to form in ingots; the products of oxidation remain in the steel; it has no effect upon sulphur and no effect on the molecular arrangement of the metal. Ferrotitanium is the most powerful deoxidiser known. Titanium does not alloy freely with iron, and imparts to steel qualities that are not acceptable to the trade. Calcium, sodium, vanadium, and boron alloys have been tried as deoxidisers, but homogeneous steel was not produced when they were used.

A Book on Titanium

THE publication of the series of monographs issued by the American Chemical Society is being steadily pressed forward. One of the latest volumes to hand is *Titanium* (with special reference to the analysis of titaniferous substances), by William M. Thornton, Jr. (New York: The Chemical Catalog Co., pp. 262. \$5). The subject is discussed under the following headings: The occurrence of titanium in nature; the general chemistry of titanium; the industrial applications of titanium and its compounds; and the detection and estimation of titanium in its various associates. A special chapter is devoted to reagents, and the book closes with a very exhaustive list of references to the original literature. As is indicated on the title-page, much attention is devoted to the analytical side, the part of the book dealing with this matter occupying about 140 pages. The chapters in this section deal with the qualitative detection of titanium; gravimetric methods of determination of the metal (the separation from other metals being discussed in detail); colorimetric methods of determination; oxidimetric methods; and the determination of titaniferous materials. In the latter chapter is a section devoted to the analysis of titanium-containing metals and alloys, which details methods for the analysis of metallic titanium, titanium carbide and ferrotitanium; for the determination of titanium in manganotitanium, cupro-titanium, and other alloys; for the determination of titanium in iron and steel (pig-iron, cast-iron, plain carbon steel and zirconium steel); and, finally, for the analysis of slags and refractories.

Fatigue of Metals: Magnetic Investigation

AN investigation on the effect of repeated stress on the magnetic properties of steel is under way in the United States Bureau of Standards. It is known that the application of static axial stresses below the elastic limit do not produce a permanent change in magnetic properties after removal of the stress. The results of the present investigation (a preliminary paper on which is in preparation) show, however, that repeated bending, such as occurs in the usual rotating beam fatigue test, results in easily measurable changes in magnetic permeability. The changes take place most rapidly in the early part of the test and proceed at a decreasing rate as the test is continued. It has been found that five cycles of stress are sufficient to bring about a measurable magnetic change. The magnitude of the magnetic change depends upon the intensity of the stress and the number of repetitions. Analysis of the data so far obtained on a single type of steel indicates that the change in magnetic permeability produced by repeated bending is of the same nature as that resulting from the relief of a comparative stress. This change is probably caused by redistribution of internal stress. This investigation is being continued, as it now appears very probable that by this method of investigation much can be learned of the fatigue of metals that could be learned in no other way.

Dismantling of Famous Steel Mills

It has been announced that Thomas W. Ward, Ltd., of Sheffield, have bought the famous Spencer Rolling Mills at Newburn-on-Tyne, and intend to dismantle them. These famous steel rolling mills have lain idle since the spring of 1924, when the firm ceased to exist as a going concern. Over 2,500 men were normally employed there, and the fame of Newburn steel was one of the boasts of Tyneside. The mills started in 1810 and kept pace with all the developments in the production of steel. The sale includes 12 Siemens-Martin smelting furnaces, and other plant, and the acreage is about 43, with a river frontage of 1,100 yards.

Trade, Commerce, Finance : The Month in Review

From Our Northern Correspondent

THE quietness which usually prevails at this season of the year has again characterised conditions in the iron and steel trade during the month of August. The general holiday with which the month started had its customary effect. Many of the works were closed for a few days, while others remained closed the whole of the week. Since then business has continued quietly on the same lines as in the previous month. There is, however, some evidence of a slight quickening. It is realised that the holiday season is nearly over, and with the approach of the last quarter of the year there are expectations of better trade. The markets have been well attended, and although there has been no large volume of business transacted, there is a more active tone in the market. Probably during the next week or two we shall see the effect of this in increased trade.

Better Prospects

This expectation has communicated itself to the Stock Exchanges as well as to the iron and steel markets. There has been a lot of buying of industrial shares, and many of the coal and steel shares have advanced appreciably in price. The fact that the season of the year is approaching when trade usually brightens up after the holiday dullness is sufficient to awaken interest, and this in turn leads to more business being done. At the same time it would be more satisfactory if there were a more solid foundation on which to base one's hopes of a trade improvement in the closing months of the year. It is realised that the steel trade is in the most critical period of its existence and that something will have to be done to ward off disaster.

It is this fact which has led to the formation of the rebate scheme which is one of the outstanding events in the history of the trade. Under this scheme rebates are to be given to consumers who use nothing but British steel, but there are one or two interesting points in connection with it which make it worth while to consider the reasons for such a proposal.

Price Regulation

At present, there is no central association of steel makers for the purpose of price regulation. Each district has its own association, the plate makers on the North-East Coast, the section makers in the Midlands, and the Scottish steel makers, and there is also the British Joist Makers' Association. Each of these has its rules for the maintenance of prices and for regulating the conditions of operation. From time to time there is a joint meeting of all these separate associations, at which the steel trade of the whole kingdom is brought under review and minimum prices are fixed for the various products within the scope of the separate associations. The maintenance of these fixed prices has been a matter of serious importance, as it is well known that unless some agreement of this kind were in force there would be wholesale price-cutting among the various steel works, as there is not enough trade to keep them all busy. The prices so fixed cannot be considered remunerative, but they are as high as it is practicable to have them in view of the foreign competition and trade conditions generally. Consequently every effort has been made to ensure that these minimum prices shall not be underquoted.

On the whole these efforts have been fairly successful, but, as pointed out on several occasions, there have been numerous instances of evasion by the associated makers. One great weakness of the position was that the combined associations did not include the whole of the makers of the scheduled products controlled by the associations, and while there was a general agreement between the associated and the non-associated makers for the maintenance of prices, it remained a source of danger that there should be any firms not bound by the agreement. The scheme now drawn up has a twofold purpose: First, to make a determined attempt to restrict the use of foreign steel in preference to British; and, secondly, to compel the whole of the makers of the controlled products to come into the scheme and thereby become pledged members of one or other of the associations.

The Rebate Scheme

In pursuance of this twofold object, a circular has been sent out to all consumers of steel in Great Britain and Ireland stating that on all sales of the controlled products within the

kingdom a rebate of 5s. per ton (7s. 6d. in the case of joists) will be paid to the consumer at stated periods on the express condition that the consumer shall have purchased the whole of his requirements of these products from one or other of the associated makers of whom a list is given in the circular. Additional rebates are to be given for orders of definite quantities of any one section of joists, up to a maximum of 12s. 6d. Forms are to be signed by the consumers agreeing to become parties to the scheme, and a declaration of compliance with the conditions has to be made before the rebate can be claimed.

There are two features worthy of note. Any consumer who becomes a party to the scheme is debarred from using foreign steel of the classes mentioned, unless he is prepared to forgo the rebate of 5s. The second point is that any steel maker who wishes to join in the scheme must be a member of one of the associations. This has removed the danger which existed so long as there were any non-associated makers, who were able to act independently of the associations. They have been compelled to become members, as otherwise their trade in the controlled products would slowly but surely disappear, as, for the purpose of the scheme, any maker who refused to join the association would have been treated in the same way as if it were a foreign company. As there was only one maker, or at the most two, of the controlled products who remained outside the associations before the scheme was drawn up, they had no choice but to become pledged members, as they could not fight the combination of the whole of the other makers.

An Ingenious Scheme

It is quite an ingenious scheme, although whether it will succeed in its ostensible purpose remains to be seen. When one compares the continental prices with the home prices it is apparent that the margin is too great to be bridged by a rebate of 5s. per ton. Continental steel can be bought at prices ranging from £7 to £7 10s. for plates and £5 15s. to £6 for sections delivered at the consumer's works here, while the home prices are £8 7s. 6d. for plates and £7 12s. 6d. for sections, less the rebate. One therefore looks for other reasons for the project, and there are two possible ones. It has long been expected that there would be a reduction in the official prices of steel, as fuel prices are now less than they were prior to the coal strike, and there is thus no apparent reason for the continuance of the advance which was put into force after the strike started. The steel associations realised that a reduction would have to be made, and this rebate scheme is a clever method of giving the reduction in such a manner as to confer the utmost benefit to the steel makers.

Prospects of the Scheme

The second possible reason is that the scheme forms a starting point for the formation of one central body which shall control the operations of the steel industry in this country. The absence of such a body has been one of the difficulties in the way of participation in the European cartel; and an essential preliminary to such participation would be the reorganisation of the steel industry so as to have one central selling organisation, the orders being pooled and distributed to the works best fitted to execute them.

The scheme came into force on September 1, and its working will be followed with great interest.

Market Conditions

There is little or no change to report in the market conditions. Apart from Cleveland pig iron and Crown bar iron, which have been reduced during the month, prices remain unchanged. There is a little better business in pig iron, but orders for this as well as for steel continue scarce. The future is uncertain, and business continues to be of a hand-to-mouth nature.

The number of blast furnaces in operation at the end of July was two less than at the beginning. The production of pig iron amounted to 645,800 tons, compared with 651,300 tons in June and 720,100 tons in May. The production of steel ingots and castings during July amounted to 682,900 tons, compared with 747,300 tons in June and 884,600 tons in May.

Some Inventions of the Month

By Our Patents Correspondent

Abstracts of other Patents of metallurgical interest will be found in our Patent Literature published weekly in THE CHEMICAL AGE.

Metallurgical Furnace

A FIXED or tilting reversible regenerative metallurgical furnace has been patented by B. Talbot, of Middlesbrough, which has an auxiliary bath at one or both ends adapted to be heated by hot waste furnace gases. A higher temperature can be obtained in these auxiliary baths by additional gas jets, and the valves for the gas and air connections may be reversed with the furnace. See Specification No. 273,779, dated March 5, 1926.

Roasting Sulphide Ores

A PROCESS has been patented for roasting fine sulphide ores obtained in the form of a sludge—e.g., by the froth flotation process. Such ores cause difficulty during roasting owing to the carrying away of the fine dust by the roasting gases. The ore is mixed with an agglomerate of the same origin which has been disintegrated to a granular size, and the mixture submitted to a blast roasting treatment. The sulphide ore and added material are in about equal proportions. See Specification 273,976 (Metallbank und Metallurgische Ges. Akt.-Ges., of Frankfurt-on-Main, Germany), dated January 21, 1927.

Refining Aluminium

ACCORDING to a process for refining aluminium, by Aluminium-Industrie Akt.-Ges., of Neuhausen, Switzerland, the impure aluminium is employed as anode in a molten electrolyte consisting of one molecular proportion of an alkali metal halide or alkaline earth metal halide and more than one molecular proportion of an aluminium halide. A mixture of sodium chloride and aluminium chloride having a melting point of 80°–100° C. is suitable, the working temperature being 120°–140° C. A voltage of 0.02–0.04 and current density of 0.5 amps. per sq. dcm. are employed. See Patent Application 272,246, having the International Convention date June 7, 1926.

Sintering Refractory Metals

REFRACTORY metals which are chemically active when hot—e.g., zirconium—can be sintered by slowly heating the pressed powder in a high vacuum to remove the occluded gases at a temperature below that at which chemical combination with the metal occurs. The metal is then cooled *in vacuo*, and heated to the sintering point as quickly as possible in a gas at moderately low pressure—e.g., 1–2 cm. of mercury, or in a high vacuum. The thin film of oxide or nitride which forms protects the metal against further action. A preliminary sintering at 800°–1,000° C. may take place before the intermediate cooling. The final heating may be by induction currents, or electric resistance. See Patent No. 274,283 (N. R. Davis, Manchester, and Metropolitan-Vickers Electrical Co., Ltd., London), dated July 26, 1926.

Removing Silica from Zinc, Copper, and Vanadium Solutions

ACCORDING to a Patent by R. H. Stevens, G. C. Norris, and W. N. Watson, of Broken Hill, Northern Rhodesia, the difficulty of separating the bulky gelatinous precipitate of silica from zinc, copper, or vanadium solutions can be avoided by agitation and heating in the presence of basic material, such as zinc oxide or lime, at a temperature of 55° C. The precipitated silica is then in granular form. The filter cake of silica is subjected to weak acid and water washing to remove any metal salts from it. The flow sheet of the process of recovering zinc electrolytically from zinc ores is given. See Patent No. 274,297, dated August 23, 1926.

Chromium Plating

ACCORDING to a process for chromium plating by General Motors Corporation of Detroit, U.S.A., an anode of iron or steel is used, and an electrolyte of chromic acid of purity not less than 97½ per cent., and 12½ grams per litre of chromium sulphate with a little boric acid or a borate. The anode is not corroded. See Patent Application No. 273,659, having the International Convention date June 30, 1926.

Alloys

AN application for a Patent has been made by S. Cholewinski of Warsaw, for an alloy for bearings, consisting of lead 97–98 per cent., calcium 0.35 per cent., barium 0.45 per cent., strontium 0.3 per cent., copper 0.5 per cent., and sodium 0.4 per cent.

Research on Sponge Iron

Interesting Possibilities

DEVELOPMENT of a limited iron and steel industry in certain western localities in the United States where, under present economic conditions, such operations are not commercially feasible, is suggested as the result of experimental work, in the production of sponge iron, performed by the United States Bureau of Mines, Department of Commerce, at its Seattle, Washington, Station. Sponge iron also promises to become of great economic importance in the leaching and precipitation of copper and lead ores. Sponge iron is the product formed by the reduction of iron oxide to metallic iron at a temperature below the fusion point of the constituents of the charge. A particle of sponge iron has the same size and shape as the particle of ore from which it was reduced, but, because of the removal of the oxygen from the oxide, it is much more porous. By reason of this porosity of sponge iron it reacts more vigorously and rapidly than the ordinary massive forms of iron. Under suitable reducing conditions sponge iron can be produced readily on a commercial scale at about 900° C., and can be magnetically separated from a large part of the associated impurities.

Sponge iron will precipitate copper, lead, and numerous other metals from solution. The reaction takes place quicker than when a massive form of iron, such as steel scrap or pig iron, is used as a precipitating reagent, and thus plant capacity is proportionately enlarged. Sponge iron is likely to be increasingly important in the hydrometallurgy of low-grade copper and complex lead ores; its production insures a permanent and reliable source of metallic iron—a matter of much importance in view of the small supply of scrap iron and the distances that separate most copper and lead mines from iron-producing centres. It is conceivable that the future success of some large-scale leaching and precipitating processes for copper and lead ores may depend largely upon a supply of cheap sponge iron. In some chemical processes finely divided metallic iron is used as a reducing agent, and iron oxide is obtained as a by-product. This oxide could be converted into sponge iron and used again in the reduction process.

"Direct Steel" Processes

The possibility of making sponge iron and converting it directly into steel, thus eliminating the pig-iron stage, has been suggested from time to time, and hundreds of so-called "direct steel" processes have been proposed or tried during the past century. Unquestionably the production of steel from sponge iron has theoretical advantages over the standard methods. Moreover, the production of both steel and pig iron from sponge iron has economic advantages in certain localities. In regions remote from iron and steel producing centres, where coke is expensive and electric energy cheap, sponge iron made cheaply from iron ore and low-grade coal can probably be converted in the electric furnace into iron and steel that can compete with the imported products. The fact that both electric melting and the production of sponge iron can be conducted economically on a small scale makes such a process particularly advantageous in communities that do not consume much iron or steel. Electric furnace processes, being inherently expensive, are not advocated for the manufacture of iron and steel except where conditions are unusual.

Other uses of sponge iron will probably be developed once production has been established on a large scale. Some experiments have been made with respect to the use of sponge iron for the production of hydrogen from steam—the iron oxide formed in the process to be converted to sponge iron. The Bureau considers that the possibilities of using sponge iron for iron or steel production in America depend entirely upon the fulfilment of certain special conditions. The important requirements for the economical use of the sponge-iron electric furnace process are: Sponge iron cheaper, per unit of contained metallic iron, than low-grade iron or steel scrap; low costs for electric furnace conversion, in particular, cheap power; high local costs for the production or transportation of iron and steel products made by standard methods. More detailed information in regard to these investigations is contained in Bulletin 270, "Production of Sponge Iron."

Current Articles Worth Noting

We give below a brief index to current articles in the technical Press dealing with metallurgical subjects.

ALLOYS.—The mixture-gap in liquid iron-copper alloys. R. Ruer. *Zeitschrift anorganische u. allgemeine Chem.*, August 5, pp. 313-325 (in German).

A study of the aluminium bronzes. I. J. Boudoires. *Revue de Métallurgie*, July, pp. 357-376 (in French).

A study of some of the causes of failure in heat-resisting alloys. R. Sutton. *Trans. Amer. Soc. Steel Treating*, August, pp. 221-234. The object of this investigation was to determine the causes of failure in heat-resisting alloys; specifically the reasons why nickel-chromium alloy carburising boxes show so large a variation in their actual life in the furnace. The type of boxes referred to are of the approximate composition 60 nickel, 18 chromium, and 15 iron. It is concluded that the principal reasons for the failure are: strains caused by non-uniform shrinking; "dirty" castings; the allotropic form of casting; the rate of cooling; incomplete deoxidation and occluded gases; and the absence of a degasifier, such as aluminium.

Aluminium bronzes. II. J. Strauss. *Trans. Amer. Soc. Steel Treating*, August, pp. 239-278. A review of the constitution, mechanical properties, and resistance to corrosion of these copper-aluminium alloys with and without the addition of other elements.

ANALYSIS.—The analysis of antimony alloys. H. Vignal. *Annales Chim. Analytique*, July 15, pp. 193-196 (in French).

CORROSION, ETC.—On the non-rusting steels. B. Strausz. *Z. Elektrochem.*, August, pp. 317-321 (in German).

The practical problems of corrosion. I. A critical study of the use of inhibitive chemicals. U. R. Evans. *J.S.C.I.*, August 26, pp. 347-355 T.

Deterioration of structural steels in the synthesis of ammonia. J. S. Vanick. *Trans. Amer. Soc. Steel Treating*, August, pp. 169-194. Used in plant for the high-pressure, high-temperature synthesis of ammonia, the plain carbon steels soon showed their susceptibility to deterioration. Early work found some degree of success in a steel of the 0.3 per cent. carbon-1.0 per cent. chromium-0.18 per cent. vanadium type, and this steel was used until the commencement of the work now reported. From the study of 10 commercial steels, subjected to 8.3 per cent. ammonia at 100 atmospheres pressure and 500° C., it was found desirable that the carbon content should be low, that increasing chromium was helpful, as was the presence of tungsten. Tests were then made on a series of chromium-vanadium steels having carbon 0.1-1.5 per cent., chromium 0.14 per cent., and vanadium 0.065 per cent., and it was found that low carbon was desirable, and that 2.25 per cent. of chromium stopped selective penetration and intergranular fissuring and limited the depth of penetration to a tolerable extent. An explanation of the mechanism of the deterioration of the steels is advanced, in which ammonia is regarded as the active corrosive.

The behaviour of bronze in cellulose bleach-liquor. W. Heike and F. Westerholt. *Z. Metallkunde*, July, pp. 285-287 (in German). The influence of tin- and lead-content, as well as tempering at 700° and 500° C. on the resistance towards attack by the bleach-liquor. The tin-content plays the most important part, that of lead being less important. Tempering at 700° C. is favourable in alloys rich in tin, unfavourable in those poor in it; the resistance is continually increased through long heating at 500° C.

GENERAL.—Researches on the electrolysis of copper in the presence of gelatin. C. Marie and A. Buffat. *J. Chim. Phys.*, July 25, pp. 470-481 (in French).

The causes of the colours shown during the oxidation of metallic copper. F. H. Constable. *Proc. Roy. Soc. A.*, August 2, pp. 570-588.

A new differential dilatometer for the determination of volume changes during solidification. C. J. Smith. *Proc. Roy. Soc. A.*, August 2, pp. 554-570.

A metallographic polishing machine. O. E. Romig and J. C. Whetzel. *Trans. Amer. Soc. Steel Treating*, August, pp. 235-238.

The rôle of dispersoidal-chemical factors in metallurgy. F. Sauerwald. *Kolloid-Zeitschrift*, July, pp. 242-253 (in German).

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

London Gazette, &c.

Company Winding Up Voluntarily

GURUM RIVER (NIGERIA) TIN MINES, LTD. C. A. Dodds, 3, Copthall Buildings, London, E.C.2, appointed as liquidator, July 26.

Mortgages and Charges

[NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]

ALUMINIUM CORPORATION, LTD., London, S.W. Registered July 28, £5,900 C debentures part of £500,000; general charge. *£1,247,522. August 12, 1926.

BARROW HEMATITE STEEL CO., LTD. Registered August 12, £19,510 2nd debenture, to Trades Development Co., Ltd., 34/6, Gresham Street, E.C.; general charge (subject to prior charge). *£1,097,879. April 5, 1927.

BEARDMORE (WILLIAM) AND CO., LTD., London, S.W., steel manufacturers. Registered August 6, Trust Deed dated August 5, 1927 (supplemental to Trust Deed dated August 9, 1904, securing £231,400 debentures outstanding), providing for increase in rate of interest, etc.; charged on property originally charged. *£1,522,731 19s. 4d. December 31, 1926.

EBBW VALE STEEL, IRON AND COAL CO., LTD. Registered July 21, charge to Bank; charged on 250 railway wagons. *£573,000 (floating charge to secure bank overdraft up to this limit) and £781,200. July 13, 1926.

INTERNATIONAL ALUMINIUM CO., LTD. (late BAUXITE REFINING CO., LTD.), London, E.C. Registered July 26, £5,600 mortgage, to Rt. Hon. Edward Sholton Baron Penrhyn, Wicken Park, Stony Stratford, and others; charged on freehold land part of Parkian Farm, Llanfairsgrgr, also leasehold land adjoining same. *Nil. December 15, 1926.

KENYON (JOHN) AND CO. (SHEFFIELD), LTD., steel manufacturers. Registered August 2, £20,000 debenture, to Engineering and Mercantile Co., Ltd., 3, New London Street, E.C.; charged on Millsands Works, Millsands, Sheffield, also general charge. *£20,000. December 31, 1926.

MONDEGO TIN DREDGING CO., LTD., London, E.C. Registered July 28, £10,000 debentures (filed under sec. 93 (3) of the Companies (Consolidation) Act 1908), present issue £2,000; general charge. *£22,500. April 26, 1926.

PALMERS SHIPBUILDING AND IRON CO., LTD., Jarrow-on-Tyne. Registered July 23, Trust Deed dated July 22, 1927 (supplemental to Trust Deed dated April 9, 1919, and supplemental Trust Deed dated March 10, 1926), securing a variation in the rate of interest on £1,066,849 outstanding debenture stock and capitalised arrears of such interest; charged on lands, premises, and shares specified in said deeds, also general charge. *£1,362,109. August 6, 1926.

PALMERS SHIPBUILDING AND IRON CO., LTD., Jarrow-on-Tyne. Registered July 4, trust deed dated June 24, 1927, securing £650,000 6 per cent. 1st debenture stock and premium of 2½ per cent.; charged on freehold and leasehold properties at Monkton, etc. 100,000 fully paid up shares of £1 each in Palmers Hebburn Co., Ltd., also general charge. *£1,362,109. August 6, 1926.

THAMES METAL CO., LTD., London, E.C. Registered July 18, £5,000 charge to C. H. Brown, 121, Victoria Street, S.W. C.A.; charged on land and property at Tower Works, Northfleet. *Nil. August 26, 1926.

Monthly Metallurgical Section

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NOTICE.—Communications relating to editorial matter for our Monthly Metallurgical Section should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Communications relating to advertisements and other business should be addressed to the Manager. Contributions will be welcomed from correspondents on any points of interest to metallurgists bearing on works practice or current research problems.

Radium and Uranium: Extraction, Properties, and Uses

By G. Malcolm Dyson, Ph.D., A.I.C.

This article is an addition to a number of others, on the production, properties, and uses of various metals, which have been written by Dr. Dyson for this supplement, in which they have appeared from time to time.

URANIUM itself is an element which has found, as yet, singularly few uses in pure metallurgy; indeed, it appears, in view of the ready oxidation, high density, and difficulty of preparation in the metallic state of the metal that uranium has very far to go before it can be considered a metallurgical success. It occupies a unique position with reference to radium, which is perhaps the most interesting of metallic elements. Uranium is one of the unstable elements, and is constantly, although slowly, changing into a series of different elements of which radium is one; in fact, we know of no manner in which radium can be produced save by the disintegration of uranium. This being so, it follows that radium must be sought for in the presence of uranium, and that when found it is accompanied by large quantities of the less valuable element. The actual ratio of the amounts of radium and uranium in any deposit depends on the age of the latter and upon the life periods of the various elements which form the degradation series between radium and uranium. The life periods of the elements concerned are usually stated thus:—

ELEMENT.	ATOMIC WEIGHT.	AVERAGE LIFE.
Uranium-1	.. 238 ..	8 × 10 ⁸ years
Uranium-X ₁	.. 234 ..	35.5 days
Uranium-X ₂	.. 234 ..	1.65 minutes
Uranium-2	.. 234 ..	3 × 10 ⁶ years
Ionium	.. 230 ..	2 × 10 ⁵ years
Radium	.. 226 ..	2440 years

It follows from such figures that since the life period of radium itself is shorter than those of the elements which precede it, that an equilibrium will be ultimately set up. The amount of radium which is present at such a point will be quite small, so that to obtain a small amount of radium a very large amount of uranium must be treated. From the point of view, therefore, of the extraction of these two elements one process alone need be considered.

Occurrence of Uranium

Of the various uranium ores which are distributed throughout the earth's crust, pitchblende and carnotite are the two which have been most widely used. Pitchblende has a rather widely varying composition and consists mainly of the mixed oxides UO_3 and UO_2 in roughly equivalent proportions, together with quantities of the oxides, sulphides, and arsenides of the metals lead, calcium, iron, bismuth, manganese, copper, and aluminium, together with a small amount of silicates. An analysis of pitchblende by Ebelmen in 1842 disclosed the following composition:—

Uranium oxides ($2\text{UO}_3, \text{UO}_2$)	75.23
Lead sulphide	4.82
Silica	3.48
Lime	5.24
Magnesia	2.07
Soda	2.05
Ferrous oxide	3.10
Manganous oxide	0.82
Carbon dioxide	3.32

The mineral carnotite presents a more definite composition, and approximates to a potassium uranyl vanadate containing water of crystallisation, $\text{K}_2\text{O} \cdot 2\text{UO}_3 \cdot \text{V}_2\text{O}_5 \cdot 3\text{H}_2\text{O}$. The only other minerals of any considerable importance were, until recently, autunite, a hydrated calcium-uranium phosphate, $\text{Ca}(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 8\text{H}_2\text{O}$, and torbenite, a similar deriva-

tive of copper, $\text{Cu}(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 8\text{H}_2\text{O}$. Recently, however, a series of minerals has been discovered in fairly rich deposits in the Belgian Congo; the three principal minerals of this series are:—

Curite	$2\text{PbO} \cdot 5\text{UO}_3 \cdot 4\text{H}_2\text{O}$
Kasolite	$3\text{PbO} \cdot 3\text{UO}_3 \cdot 3\text{SiO}_2 \cdot 4\text{H}_2\text{O}$
Soddite	$12\text{UO}_3 \cdot 5\text{SiO}_2 \cdot 14\text{H}_2\text{O}$

The distribution of the uranium minerals, especially of pitchblende, is comparatively wide. The most famous mines are those of St. Joachimsthal. They were opened for silver in 1517, but in 1545 the silver began to "peter out." Since then nearly every known metal has been found in these mines, in one form or another. The pitchblende occurs there in small veins in beds of lime schist and gneiss, intruded with porphyry. A somewhat similar geological formation is associated with the Cornwall deposits of pitchblende, which are often to be found in slate intruded with greenstone and granite porphyry. Possibly the largest deposits of carnotite occur in Colorado, where the radium content of the ore is often as high as 5 to 10 mg. per ton.

Treatment of the Ores

The older methods for the preparation of radium-barium concentrates from the uranium minerals differed very little from one another. The ore was ground and fused with sodium carbonate, which process converted the uranium to sodium uranate. The residue was treated with dilute sulphuric acid, when the sodium uranate dissolved, leaving the radium in the residues as the sulphate, together with some calcium and barium sulphates and siliceous matter. The residues were then boiled repeatedly for long periods with a solution of sodium carbonate, which gradually converted the radium to the carbonate, which is soluble in dilute hydrochloric acid. To the acid extract was added a certain amount of barium chloride and some dilute sulphuric acid, insufficient of the latter being added to precipitate all the barium. The radium sulphate was carried down along with the barium sulphate, and the mixed sulphates were then filtered off and treated as barium-radium concentrates.

A similar process can be applied to carnotite, and still serves as the best method for its utilisation. In practice the sodium carbonate fusion is substituted in the case of carnotite by a boiling with strong sodium carbonate solution. The filtered solution contains the uranium, whilst the radium remains in the residues and may be obtained by extraction with very dilute hydrochloric acid. It is converted to barium-radium concentrates in the manner described above. It may be added here that the precipitation of the radium along with the barium sulphate is not purely a question of simple precipitation. In many cases the amount of radium is so small that the solution could hold it without any precipitation; the phenomenon of adsorption is called into play when the barium sulphate takes the radium sulphate with it.

Various modern methods for the treatment of pitchblende have been devised. The first differs but little from the older process, save that the second precipitation is avoided. The residue from the sodium carbonate fusion is extracted with hot water in place of sulphuric acid. The consequence is that although the uranium dissolves as sodium uranate, the radium remains behind as the carbonate instead of the sulphate.

The older process repeated the carbonation process in order to obtain the barium-radium concentrates in a soluble state for fractional recrystallisation, but more modern processes involve the reduction of the sulphate to the sulphide in coal gas at 725° to 740° C., a procedure which is, however, less efficient than the admixture of the sulphates with one-fifth of their weight of powdered charcoal, followed by eight hours heating in a graphite crucible at 800° C. The residue is added to boiling dilute hydrochloric acid, when solution takes place with the evolution of hydrogen sulphide. The well-boiled and filtered solution is gently evaporated to dryness, and the residue submitted to fractional crystallisation. This process is quite simple, although tedious and requiring systematic

adherence to a carefully worked-out plan. The crystallising flasks, usually of silica, are arranged in batches of six. The crude salt which contains about one part of radium in 10^6 is recrystallised in the extreme right pot. The crystals which separate contain more radium than those remaining in solution. Thus the crystals pass from right to left through the series, becoming increasingly rich in radium, while the mother-liquor which passes in the opposite direction becomes almost free from radium (about 2 to 3 parts in 10^6). After three series of crystallisation, the radium content is 5 to 10 parts per 10^6 . All other metals save barium and a little lead have by this time been removed, but before further purification, the remaining lead is removed as sulphide. The next stage is to convert the chlorides into bromides. The chloride solution is precipitated with powdered ammonium carbonate. The mixture is allowed to stand twenty-four hours, after which the carbonate is dissolved in 25 per cent. hydrobromic acid from which menstrium the bromide is repeatedly recrystallised.

Ten to twelve fractionations are carried through on the bromide, after which the enriched bromides are sealed up until sufficient have been accumulated for a further series of crystallisations. The separation from 25 per cent. hydrobromic acid (factor = 2) is more rapid than with the aqueous crystallisations, and a radium-rich fraction is soon obtained. It is sealed up in a tube containing an inserted platinum wire, which can be earthed.

Radium salts, when allowed to stand, become rose pink, especially if an almost equal amount of barium chloride be present. The metal itself has been prepared by the electrolysis of radium chloride, the anode being of platinum-iridium, and the cathode being of mercury, in which latter the radium collected. The mercury-radium amalgam was heated in a current of pure hydrogen, when the mercury volatilised leaving radium metal as a brilliant white metal fusing at 700°C . It appears to be very reactive, decomposing water very violently and forming a soluble oxide.

Production of Aluminium from Clay

American Investigation of Acid Extraction

STUDIES for the development of acid extraction processes leading to cheaper methods for the production of aluminium metal from clays and other aluminium silicates which are very abundant in nature have been completed by investigators of the United States Bureau of Mines, Department of Commerce. The amount of low-silica bauxite, from which aluminium is at present principally obtained, available at low cost in the United States is not large, the Bureau points out, and imports of bauxite used by the American aluminium industry are increasing. Many power sites of the western Intermountain region could produce aluminium cheaply if a satisfactory source of aluminium oxide were available.

The Bayer Process for Pure Alumina

In the United States the chief method for making pure alumina for use in the aluminium and chemical industries is the Bayer process, state G. S. Tilley, R. W. Millar, and O. C. Ralston, in a report just issued. This process requires the use of bauxite as raw material. Moreover, the bauxite must have a low content of siliceous impurities, because during the process alumina is dissolved from the crude raw material by means of caustic soda solutions which also attack silica. The silica in turn forms with sodium and alumina an insoluble compound which remains in the residue, causing prohibitive losses of alumina and soda. Iron in the bauxite is not a deleterious impurity. Few deposits of pure bauxite are known, and the impure bauxites are generally divided into high-silica and low-silica (with low or high iron) bauxites. The latter are worked at present.

The main American production of low-silica bauxite comes from Arkansas, although some is found in Tennessee, Alabama, and Georgia. Imports of bauxite from British Guiana, Dalmatia, and France are increasing, and governmental and other restrictions have been placed on exports from Guiana. Moreover, aluminium is now produced only at such water-power sites as are easily available from the present sources of low-silica bauxite. Many power sites in the Rocky Mountain region are close to good supplies of clays or other aluminium silicates, and also to sources of supply of sulphuric acid, which can be produced very cheaply because the sulphur dioxide from which it can be made is now being wasted at many places. In Utah, Arizona, and Montana combined, the wastage of sulphur dioxide runs, not into hundreds of tons, but into several thousands of tons daily.

Application of Acid Processes to Siliceous Bauxite

With this situation in view, the Bureau of Mines decided to make a study of acid processes of extracting alumina. Acid processes do not suffer from silica contamination in the same way that the Bayer process does, and consequently they can be applied to the siliceous bauxites now unused by the Bayer process. On the other hand, these processes would have difficulty in handling the high-iron bauxites suitable for the Bayer process. On that account the acid processes need not compete with the Bayer process for raw material. Kaolin, alunite, leucite, glauconite, and other minerals suitable

for acid decomposition are widespread; acid plants for producing alumina need not be restricted to a few localities, as those using the Bayer process now are.

The exact proposal studied by the Bureau of Mines was to treat a clay, alunite, or other material capable of decomposition by sulphuric acid, and then dissolve the resulting aluminium sulphate in water, the water being kept at the minimum in order to avoid excessive evaporation later in the process. This aluminium sulphate solution contains as its main impurities iron, titanium, and silicic acid. Alkali metal sulphates are also present. By neutralising the excess acid the silica, titanium, and iron compounds can, by proper manipulation, be successfully thrown out of the solution and the resulting aluminium sulphate solution is ready for sedimentation, filtering, or other treatment to separate the impurities. This solution can then be evaporated and crystallised. The alkaline sulphates form alums which tend to crystallise before the aluminium sulphate does. Spray drying of the solution is also possible. The aluminium sulphate crystals contain much water of crystallisation which must be properly eliminated; the resulting "burnt alum" can then be calcined at such a temperature that it will be dissociated thermally into aluminium oxide and the oxides of sulphur. The gases containing the oxides of sulphur are to go back to a sulphuric acid plant for return to the process.

Further details are given in Bureau of Mines Bulletin 267, "Acid Processes for the Extraction of Alumina," which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C., at a price of 15 cents.

Sheepbridge Coal and Iron Co.

THE ordinary general meeting of the Sheepbridge Coal and Iron Co., Ltd., was held at Sheffield on Monday, the chairman, Lord Aberconway, presiding. In regard to the company's iron works, Lord Aberconway stated that they had put a furnace into blast as soon as the strike ended. The second furnace they were now rebuilding. Pig iron prices remained at an unremunerative level owing to the importation of iron from France. The price of coke had fallen, but it was not possible under existing conditions to produce pig iron at an economic figure; but in the case of Sheepbridge the furnace carried overhead charges and supplied gas, slag, and pig iron for the works to the general advantage of the business, and therefore it was clearly in their interest to go on making iron. There had been sufficient demand to clear away nearly the whole of their stocks of pig iron and to clear their make from week to week, and, as there had been a fair demand for both dry and tar slag during the year and the foundries had been fairly well employed, it was obvious that they had not been losing by the operation of their blast furnace. There had been a good demand for pipes, but for the general castings orders had not been sufficient to keep the foundries employed to their full capacity.

Metallurgical Topics: Monthly Notes and Comments

From Our Own Correspondents

Institute of Metals: Programme for 1927-28

THE Council of the Institute of Metals has just issued the 1927-28 programme of the Institute, and of its Local Sections in Birmingham, Glasgow, London, Newcastle-on-Tyne, Sheffield, and Swansea. Over thirty papers are enumerated, covering such practical subjects as brassfoundry practice, permanent mould casting in aluminium alloys, special alloys in relation to the corrosion problem, gases in metals with particular reference to copper, and some metallurgical problems of the electrical industry. The general meetings of the Institute are as follows: March 7 and 8, 1928, annual general meeting, in the hall of the Institution of Mechanical Engineers, London; March 7, 1928, annual dinner and dance; May 8, 1928, annual May lecture; September 4 to 7, 1928, annual autumn meeting, in Liverpool. Copies of the programme can be obtained from the secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1. The commencement of the 1927-28 session of the Institute coincides with the opening of new offices and of an additional library and reading room at 36, Victoria Street, London, S.W.1. The latter is pleasantly situated and comfortably furnished; it should prove an attractive meeting place for members when in London. New members, as well as old, will be welcomed by the Institute to take advantage of these increased facilities. In March next the Institute celebrates its twentieth anniversary, and it is expected that by then the membership will have increased to two thousand. There has just been published an interesting booklet giving an account of the objects and work of the Institute. Copies are obtainable from the Secretary of the Institute at the above address.

Silica Gel in Iron Metallurgy

THE resources of colloid chemistry and the influence of catalysts, activators, and accelerators have been abundantly and successfully exploited of late in chemical technology, but much less so in practical metallurgical applications. There are, however, indications that metallurgists are beginning to recognise the possibilities of the results of research along such lines, and are even putting into practical application some of the results derived from such studies in other industries. Colloid chemistry may yet be invoked to supply an alternative to or to amplify the amorphous theory of strained metals. There are more than hints of some of these things in several papers read at the Glasgow meeting of the Iron and Steel Institute, held last week. From a practical point of view, the palm, in regard to interest, must be awarded to the paper by Mr. Lewis, on the use of silica gel for drying the blast in blast furnace practice. Silica gel is, at present, the most important of colloids industrially. Many of its applications in industrial chemistry are familiar to readers of THE CHEMICAL AGE.

The Wishaw Experiments

MR. LEWIS (whose paper was discussed at length in the last issue of THE CHEMICAL AGE) describes the air blast drying plant at the Wishaw Works of the Glasgow Iron and Steel Co., Ltd. This plant, which is the first of its kind in the world so far as blast furnace practice is concerned, is designed to treat 35,000 cubic feet of air per minute, containing a maximum of 6 grains of moisture per cubic foot of air, and reduces the moisture to not more than 1.5 grains per cubic foot. The silica gel is disposed in trays, and is reactivated, from time to time, by the simple process of heating it. Before the plant was put into operation last May, both the moisture and the ore-to-coal ratio at the company's blast furnaces used to vary within wide limits, and in very close proportion to one another. During the period described by Mr. Lewis, results of far greater uniformity have been obtained, with economy of fuel and the economy of the accompanying greater efficiency with which the furnaces work, and the greater pig iron yield they produce. With the diminished moisture content of the blast the output per furnace has been increased 17 per cent., with a fuel saving of nearly 5 lb. of coal per ton of pig iron effected. There are corresponding indirect economies as well, as is always the case when manufacturing processes are improved. There have been many processes for drying the blast, but

some of them have proved too expensive to be usefully applied in British blast furnace practice. There is, too, a further interesting factor in blast furnace practice, and that is that it is not advantageous entirely to desiccate the blast. A minimum of water vapour exercises mysterious catalytic functions in the zones of reduction, and helps in the process. The silica gel method seems likely to solve a problem which has hitherto evaded all attempts to combine what is theoretically possible with what is economically feasible in blast furnace practice.

During the discussion of the paper, Professor C. H. Desch pointed out that the process of using some absorbing material for the moisture in blast furnace operation depended entirely on the perfect reversibility of the drying agent, and he understood that experiments made in Germany with calcium chloride failed because the process could never be made perfectly reversible. A very slight overheating during reactivation spoiled the calcium chloride. The remarkable feature of silica gel was its perfect reversibility. He, personally, had had occasion to watch the behaviour of silica gel in entirely different experiments—namely, on the absorption of various organic vapours—and it had been proved that silica gel could be used for years over and over again for absorbing all kinds of vapours. The original specimen of silica gel was taken, after three years, and subjected to the first experiment which had been made, and the absorption curve obtained was exactly the same as it was originally. There seemed no reason why silica gel should not remain good indefinitely.

Science in the Foundry

THERE are some good, sound, practical men who consider that the slogan "Science in the Foundry" has been a bit overdone of late. Casting metal so as to make good castings of the right strength and soundness is an art, and there is something to be said—as there usually is—on both sides. Much immature science has been misapplied in foundry practice and empiricists rejoice accordingly. In the meantime useful work is still being done along both lines: experience widens and improves in proportion as it is carefully tested and recorded, and in so far as the conclusions drawn from such experience are logically and properly drawn. As long as papers read before societies and institutions are written by men of experience in foundry matters, and are not written over the heads of those for whom they are ostensibly intended, much useful "science" can be imparted in a tactful way, and without a display of highbrow learning which a plain foundryman is apt to resent. The young man fresh from college, with scientific training sometimes imparted in a bookish way, can work a good deal of havoc in a very short time in any foundry unless he early recognises his limitations.

Amber Oil as a Core Binder

THE *Giesserei Zeitung* has recently published some very interesting particulars, based upon the work of Professor Osann, on the use of amber oil as a core binder. Reasoning from analogy, and in view of the known usefulness of rosin oil, experiments were made and it was found that, like linseed oil, amber oil would bind pure quartz sand of suitable grain and size, yielding, after drying, very strong cores. Thus, in making radiator cores with amber oil as a binder it was found unnecessary to use core irons, and after casting, the sand was easily and completely removed by tapping the castings, which were found to be smooth, clean, and dense. The proportion of amber oil used was 4 or 5 per cent., and the temperature of drying found to yield the most satisfactory results was 150° to 200° C., the greatest strength being usually developed at 175° C. In the case of 4 in. cores, drying should last from two to three hours, and the cores should be put into the drying ovens before they have been left standing too long. With either dry or wet sand the mechanical strength of such cores was found to be excellent. The amber oil can be mixed with molasses, even better results being then obtained.

Zirconia Bricks

GREAT things were expected of zirconia, but they have not matured. The material is certainly refractory, in a colloquial sense as well as in a scientific one. Le Coultre and Carl, in

Stahl und Eisen, have published some results of tests of zirconia bricks having the following composition:—

Silica	27.7 per cent.
Zirconia	59.8 „ „
Iron	9.2 „ „
Calcium	0.1 „ „
Titanium	1.1 „ „

They were nearly twice as brittle as fireclay or silica bricks, and six times as brittle as alumina bricks, but their compressive strength was nearly double that of fireclay, and their tensile strength much greater than that of other refractory materials, including carborundum. In regard to density and porosity they likewise compared very favourably. Their softening temperature was 900° C. higher than fireclay and 600° C. higher than carborundum, and their melting temperature was 2600° C. (the same as the softening temperature), whereas carborundum brick melted at 1700° C. For many practical purposes their low thermal expansion at high temperatures should recommend them. The thermal coefficient of expansion is only half that of most fireclay materials. Zirconia bricks are very inert to chemical influences, and are not attacked by hydrofluoric acid or by bisulphates. Some results of their use in an open hearth furnace were given. The wear, after working 120 charges of 40 tons was only 12 centimetres, as against 40 centimetres in the case of silica bricks. Although the price of zirconia bricks is high, the longer life of a furnace, and the consequent increased capacity and lower repair charges, may compensate for the higher initial outlay.

Induction Melting

THE recognised merits of high frequency induction furnaces for the melting and refining of steel was emphasised by D. F. Campbell in a paper read before the Glasgow meeting. It was stated that heating and melting were effected very rapidly, and that it was possible to melt 18 per cent. tungsten steel in 3 cwt. lots in 45 minutes, the cost of melting being equal to that in the case of Héroult arc furnaces. In high-frequency furnaces the electric current causes a very rapid rotating movement of the metal in the vertical plane, the speed of rotation being so great that in a bath of steel 15 in. in diameter the centre of the bath rises more than 1 in. above the metal at the circumference. This rapid circulation of the metal in contact with the slag quickly refines the metal, the heat transference between it and the slag being sufficient to maintain the latter in a fluid condition, and to ensure that intimate contact which is so essential to rapid and efficient refining. For example, a bath of steel containing 0.7 per cent. of carbon was left in contact with a slag containing oxide of iron for ten minutes, by which time the carbon was reduced to 0.24 per cent.

Installations for the manufacture of tool steel usually consist of furnaces of 400 to 500 lb. melting capacity, and each supplied with 150 kVA from a motor generator, the power factors of the furnaces being corrected by condensers. The output of such a furnace is about 450 lb. per hour, or about 4 tons per 24 hours, the exact output depending upon the quality of steel made and the number of ingots cast. Another typical application is the use of these furnaces in foundries making small castings. The high and uniform rate of heating of a mass of steel by high-frequency induction is also being applied to the heating of billets for tube-making, with prospects of success, and by special study it has been found possible to develop useful apparatus for the heating of mining drill steel, and the continuous heating of ½-in. steel rods at the rate of 60 ft. per minute. The latter apparatus is likely to prove of value for patenting of wire and rods, for the heating of bars for nut and bolt making, and for miscellaneous forging operations.

Pulverised Fuel in Cupola Blast

THE elasticity of pulverised fuel, whether for heating or power, is exemplified in the latest account, given in *Stahl und Eisen*, of its use in cupola practice. The influence of the introduction of coal dust with the blast into foundry cupolas on the success of the cupola process was made the subject of two comparative experiments, both of which were carried out in the same cupola. By changing the fuel conditions of the charge from 11 per cent. coke to about 7 per cent. coke, 0.8 and 0.9 per cent. coal dust respectively, the following advantages

were obtained:—(1) The melting capacity of the furnace was increased by 30.8 per cent. under normal operating conditions, and by 23 per cent. with forced draught; (2) the heat efficiency was increased by 30 to 37 per cent. and to even higher; (3) the amount of coke used was decreased by 37 and 36 per cent., respectively, whilst the total amount of fuel required was lowered by 29 and 31 per cent., respectively; (4) a saving in blast air of 21 and 20 per cent., respectively, was effected; (5) on account of the decreased amount of fuel used, the sulphur content of the iron was lowered by about 19 per cent.; (6) the quantities of slag produced were also decreased, in accordance with the smaller quantities of coke and lime employed. The loss of iron amounted to 0.25 and 0.34 per cent., respectively, as against a loss of 0.23 and 0.27 per cent. if the cupola was operated without coal dust additions. Thus there was no increased loss of iron by slagging. There appear to be no disadvantages whatsoever likely to accrue from the addition of coal dust in cupola practice.

Non-Ferrous Metals: Census of Production

PRELIMINARY report No. 22 of the Census of Production (1924), dealing with the non-ferrous metals trades, was published in the *Board of Trade Journal* recently. The particulars of output of firms engaged in smelting, rolling, and casting include the following: brass and alloys of copper, value £11,511,000; copper (including copper sulphate), value £8,398,000; aluminium, value £3,774,000; antimony, 4,200 tons, value £195,000; lead (including white lead), value £8,299,000; nickel, 10,400 tons, value £1,169,000; nickel alloys, 4,300 tons, value £645,000; tin (including soft solder), £10,868,000; tungsten, 712,000 lb., value £103,000; white metal alloys (alloys of tin, lead, zinc, antimony, etc., other than soft solder), value £1,563,000; zinc (including zinc oxide), value £1,795,000; total value, £52,573,000.

Corrosion of Copper Pipes

DISCUSSING the corrosion of copper pipes, Messrs. A. F. Dufton and F. L. Brady, of the Building Research Station, in a recent note in *Nature*, state that the presence of a metal tends to inhibit the corrosion of a more electro-positive metal. On the other hand, when a metal is coated with a material to which it is electro-negative, it is well known that intense local corrosion is apt to ensue if defects arise in the coating. Copper utensils are effectively protected by a coating of tin, the potential between copper and tin being about +0.4 volt. Tin, however, is not a suitable lining for copper water pipes. The explanation of this anomaly is that in a pipe the tin lining does not keep bright. On tarnishing it becomes more electro-positive and is ultimately electro-positive to copper. In this condition it is pernicious. The potential between copper and the tarnished tin lining of a pipe (in water) was found to be -0.1 volt; this pipe failed by local corrosion.

Hours in the Steel Industry

AN assertion in a London morning paper that Dorman Long and Co. propose to repudiate the three-shift agreement, so far as it applies to the steel mill workers at their Port Clarence works, and to introduce two 10-hour shifts, has been categorically denied by Dorman Long and Co., who state officially that they know nothing about such a proposal. The suggestion in the article referred to was that the introduction of two 10-hour shifts, instead of three 8-hour shifts, as at present, would result in the unemployment of one shift, consequently increasing the number of unemployed men in the district. Dorman Long and Co. have always conformed to the national agreement, which covers the working hours and conditions of the men engaged in the steel trade, and there is not the slightest truth in the suggestion that they intend to depart from it. The iron and steel trades have been free from any serious disputes for a long number of years. The two national bodies representing the manufacturers and the employees have shown ability to manage their affairs with the minimum of friction and with the maximum of good feeling and co-operation. Any attempt on the part of any of the members of the Employers' Association to depart from the terms of the national agreement without giving notice of the contemplated changes is contrary to the practice which has been observed in the past, and the proposal is not regarded at all seriously in Tees-side steel circles.

Trade, Commerce, Finance: The Month in Review

From Our Northern Correspondent

THERE has been a little more liveliness in the iron and steel trade during the past month, and although this has not yet resulted in a definite increase in the volume of business passing, there is a more optimistic outlook for the autumn season and a somewhat brighter tone is evident in the market. This is no doubt due to a large extent to the influence of past experience, which has shown that there is always a quickening of trade after the holiday season is over. The new rebate scheme has also contributed a little to this condition. It is now a month since the scheme was launched, but it has not yet had time to reveal its full effect on the trade. It has not caused much excitement. There is considerable adverse criticism levelled against it, and there are numerous questions being raised as to its operation. Many of them have to deal with details of the payment of the rebate, but there are some which concern the general policy of the scheme, and the settlement of these may have an important influence on its success.

The Rebate Question

The avowed main object is to reduce the importation of foreign steel by substituting the British product, and thereby to increase output in this country and so reduce the cost of manufacture. This reduction of cost is a vital necessity to the iron and steel trade. The rebate of 5s. is a reduction in selling price which the trade can ill afford; in fact in many cases the works definitely cannot afford to make the reduction unless they can get compensation in the cost of production. At present increased output seems to be the only solution, and unless the scheme provides this increase the position is going to be worse than ever. Whether there will be an adequate reduction in the amount of foreign steel consumed remains to be seen, and it is very difficult to form an opinion about it just now.

There are still considerable balances of contracts entered into before September 1 to be wiped off, and until these are completed the true position cannot be easily gauged. Many consumers, who had previously used only British steel, were compelled to fall back on foreign supplies during the coal strike when the home works were closed down, and unfortunately many of them have discovered that the cheaper foreign steel answers their purpose quite well, the chief drawbacks being the uncertainty as to delivery and uniformity of quality. Probably the rebate will have the effect of regaining the bulk of this trade, but it is not unlikely that some of the consumers will continue using the foreign steel even at the risk of losing the rebate, as the saving on the one hand may more than compensate for the loss on the other; and if this is done there will always be the incentive to such consumers to increase the use of imported steel and so to reduce the disability they may suffer in respect of the British steel they have to buy.

Attitude of the Merchants

The attitude of the merchants is also of importance. There is a rather widespread feeling that the scheme will interfere with their business. The ordinary merchants, as distinguished from the stockholders, cannot claim the rebate themselves; the claim must be made by the consumer, which means that the consumer will be put into direct touch with the works, and this may lead to a transference of some business from the merchants to the works. This will arouse opposition, and if the merchants find their fears realised they may be induced to work actively against the scheme by pushing foreign steel. Generally the position of merchants under the scheme is not too clearly defined, and there are certain essential points which require elucidation. No doubt these will be dealt with in a friendly spirit, so that this endeavour to rescue the British steel industry from its perilous condition may have a fair chance of success.

It is not to be expected that the Continental makers will remain inactive if the rebate scheme seems likely to jeopardise their trade in this country. In Germany the matter is being very closely watched, and already prices have been reduced in order to meet this threat. So far there is no noticeable change in the demand for Continental steel, as a large proportion of the imports are in materials which are not affected by the scheme, such as billets and small bars; but it is

certain that the English market will not be relinquished by the foreign makers without severe competitive efforts to retain it.

The Quality Steel Market

There is another point worthy of note. Hitherto the competition from abroad has been chiefly in ordinary steels, but there is evidence that the German steel makers are paying more attention to the quality steels, and that they intend making a bid for the English market in these.

There is one matter of considerable interest in connection with the new scheme. Although consumers are compelled to confine their purchases of the controlled materials to the listed makers, there is nothing in the regulations to prevent these makers from buying foreign steel and selling it to their customers. It is known that some of the works have been buying semi-finished steel abroad and rolling it down for sale in this country, and they can continue to do so unless the customer requires a guarantee that the steel he buys is entirely British, in which case the guarantee will be given. It would be better if the conditions of the scheme were such that no foreign steel could be used by the makers who are parties to it in fulfilling orders for the controlled materials. No doubt all these questions will be satisfactorily answered shortly, so that the scheme can prove its worth.

There is not yet much change in the market conditions. There has been no rush to buy, and most consumers are still pursuing their waiting policy. They are in a good position to do so, as the contracts entered into prior to the commencement of the scheme will carry them on for a time. Most of the works are fairly busy, and it is stated that there are less unemployed in the iron and steel trades now than at any time since 1920. If this position is to be maintained there will have to be an increase in the business placed, as most firms are still experiencing a more or less gradual decline in the weight of orders on the books, and unless the expected autumn revival materialises before long unemployment is bound to increase.

The Market Position

The pig iron market is showing signs of recovery from the recent depression, and although prices have fallen during the past few weeks, the market is now firm, and the tendency is for prices to increase. Current orders are about sufficient to absorb the limited production, and stocks are not being increased at the makers' works. This is the least depressed branch of the trade. The position is somewhat similar with regard to hematite. There have been several attempts to secure further reductions in price for both East Coast and West Coast brands, but makers are taking a very firm attitude and have resolutely declined to lower the price, preferring rather to curtail production. There has been a fair amount of buying, as consumers are of opinion that although there is not likely to be an immediate advance, it is good business to buy forward at the present prices.

In finished steel the prices remain unchanged, and as all the makers are parties to the rebate scheme the official minimum figures are being strictly maintained. In small bars, which are outside the scheme, there is a good deal of competition and prices are very lean. There is not only the competition of imported bars, but also the competition from the re-rollers who use the cheap foreign billets, and this competition is being increasingly felt not only in the ordinary qualities but also in the better steels for bright drawing, etc. The demand for steel plates is not brisk and the mills are feeling the lack of specifications. Foreign competition in this line is not so severe; the real trouble is the over-supply from the mills at home. The price of boiler plates has been reduced 10s. per ton, making the official price £11, although there is no difficulty in placing orders under this price.

The production figures for August show a decline as compared with July. This may be due to holiday stoppages and to the falling orders books. The output of pig iron was 596,100 tons, as compared with 645,800 tons in July, the number of furnaces in blast being nine less at the end of the month than at the beginning. The output of steel amounted to 645,500 tons, compared with 687,100 tons in July.

Some Inventions of the Month

By Our Patents Correspondent

Abstracts of other Patents of metallurgical interest will be found in our Patent Literature published weekly in THE CHEMICAL AGE.

Iron and Steel

In a recent patent application, F. Krupp, Akt.-Ges., Essen, Germany, state that low-carbon irons and steels can be rendered insensitive to the destructive action of liquids, gases, or vapours by quenching at a temperature in excess of 650° C., the precise temperature varying with the particular material. The latter may then be drawn at temperatures not above 750° C. See Patent Application 274,016, having the International Convention date July 7, 1926.

The same firm describe cast irons which are non-magnetic or only weakly magnetic, and which contain 6 to 12 per cent. of manganese and 3 to 7 per cent. of silicon, or about 3 per cent. of carbon, 3 to 8 per cent. of manganese, 1 to 5 per cent. of silicon, and up to 4 per cent. of nickel. See Patent Application 274,035, having the International Convention date July 9, 1926.

Silicon-iron for use as a magnetic alloy should be as free as possible from slag and other solid inclusions such as silica, and should contain the silicon within narrow limits. V. B. Browne, of Tarentum, Pennsylvania, U.S.A., proposes to attain these ends by storing the molten metal, after production in the usual furnaces, in a relatively large receptacle, in which the slag and impurities can separate out. Small tappings are made at intervals, a corresponding amount of metal being added from the production furnace. The composition of the metal in the storage vessel is determined at intervals and any adjustment made either to the back itself or to the tappings. Owing to the large amount of metal in the storage vessel, relative to the amount of each tapping, its composition remains very constant. See Patent No. 276,190, having the date October 25, 1926.

According to a patent by Sir R. A. Hadfield, F.R.S., manganese steels containing 11 per cent. and upwards of manganese are considerably improved, and yield better castings, free from cracks, if the phosphorus content is reduced below 0.065 per cent. Such steel can be produced by melting carbon steel in a basic electric furnace, reducing the carbon and phosphorus to small percentages, and adding the necessary amount of ferro-manganese also low in phosphorus. Thus the melted scrap may be treated with iron ore, and suitable slag-forming materials (lime and fluor spar) to remove carbon, sulphur, and phosphorus; after an addition of ferro-silicon and further small amounts of limestone, fluor spar, and anthracite, the ferro-manganese is added and the metal cast. The manganese steel is particularly suitable for the track structures of railways, tramways, and the like. See Patent No. 276,048, having the date May 11, 1926.

Electrolytic Methods

ACCORDING to a patent application by Soc. Italiana di Elettrochimica, Rome, the aluminium hydroxide to be used for electrolytic production of aluminium is first agglomerated by compression or by use of a binder such as gelatine, glue, or other colloids, or acids or salts. See Patent Application 274,108, having the International Convention date July 8, 1926.

In a recent patent application, R. Appel, of Berlin, describes a process of chromium plating in which the electrolyte consists of a solution of chromic acid or of an acidified chromate solution, to which is added a small quantity of one or more borates or iodates; sulphuric acid should be present and lead anodes are employed. According to an example, the bath contains 5 per cent. of chromium trioxide and 0.5 gms. per litre or less of borax or sodium or potassium iodate. See Patent Application 274,882, having the International Convention date July 21, 1926.

Briquetting Ores

THE briquetting of fine ores, flue dust, or fuel is effected with an addition of 3 to 6 per cent. of clay which has been very finely ground, preferably in a colloid mill; sulphite waste liquor may be added to increase the strength of the briquettes. See Patent Application 274,876, having the International Convention date July 24, 1926.

Reducing Ores

ACCORDING to a patent by D. M. Crist, San Francisco, U.S.A., ores are treated in an externally heated furnace, with a hydrocarbon as reducing agent. When a heavy hydrocarbon is used for this purpose, the ore is reduced, and, in addition, quantities of lighter hydrocarbon vapours and gases escape, and may be condensed and utilised. An apparatus is described in which the ore is treated in an electrically-heated rotary tube furnace, provided with a suitable air-tight receiver for the reduction products and suitable condensing apparatus for the light hydrocarbons. See Patent No. 275,791, having the date August 10, 1926.

Copper

In a patent by J. Y. Johnson, London (a communication from Duisburger Kupferhütte, Duisburg, Germany), is described a method of working up the copper-containing solutions obtained by leaching chlorinated burnt pyrites or similar solutions. Such solutions have formerly been treated with zinc hydroxide to precipitate copper hydroxide, but in the present case, after such precipitation, sodium sulphate is removed from the remaining solution by cooling and the remaining sulphur precipitated as calcium sulphate by addition of calcium chloride. After precipitating any small quantities of copper nickel, cobalt, and precious metals (for example, by addition of zinc dust), the zinc in solution is precipitated by lime as zinc hydroxide, which is then available for use in a fresh cycle of operations. The precipitation of the copper is preferably effected in stages, the zinc-containing precipitates produced in the later stages being used to treat fresh solutions. The copper-containing precipitates are worked up by solution in sulphuric acid (spent electrolyte) and subsequent electrolysis after removal of chlorine ions by means of metallic copper. See Patent No. 276,200, having the date November 18, 1926.

Steel Rebate: Makers' Statement

SINCE the British steel rebate scheme came into operation at the beginning of September it has been keenly discussed, and considerable conjecture has arisen as to what reception it was receiving from the consumers, on whose support its success depends. Special interest therefore attaches to the first official statement made on the subject on behalf of the representatives of the 28 producing firms who are signatories of the scheme. It is stated that the makers are encouraged by the way the rebate system has been received in the country, both by consumers and the general public. Certain opposition is being encountered from those who are largely interested in the importation of foreign steel, but this was expected.

With regard to the question as to whether the makers who are parties to the rebate system are using any foreign steel in the production of the materials covered by the rebate scheme, information in the hands of the makers indicates that practically 100 per cent. of the defined materials produced in the works of the associated makers is being rolled from British steel. The makers agreed that if any buyer is desirous of having an individual guarantee that the material he purchases is produced from British steel this will be obtainable from the maker concerned.

Claims for New Steelmaking Process

PRESS statements have recently appeared to the effect that steel makers in Great Britain have been examining the claims of Mr. Lindley Duffield, formerly a mining engineer in Australia, but now in practice in London, in regard to a new process of manufacturing high-purity steel at a cost approximately half that of present methods. Mr. Duffield has drawn attention to the importance of the iron ore deposits in Oxfordshire and Northamptonshire, which, in his opinion, could be smelted on the spot by his method, which requires only slack to produce "gyro gas."

Rustless Steel in Germany

FOLLOWING the grant of a licence last May to the German Steel Trust by the American Rolling Mill Company of Middleton (Ohio) to manufacture rustless iron, the German Trust and Krupps have now (states *The Times*) purchased the right to exploit the patent of the Stainless Iron and Alloys Co., Ltd., London.

Current Articles Worth Noting

We give below a brief index to current articles in the technical Press dealing with metallurgical subjects.

- ALLOYS.**—On the transformations of silver-zinc alloys in crystalline states. G. I. Petrenko. *Z. anorg. u. allg. Chem.*, August 19, pp. 297-304 (in German).
- The heat treatment and development of structure of (α + β)-brass. R. Hinzmann. *Z. Metallkunde*, August, pp. 297-303 (in German).
- ANALYSIS.**—The quantitative spectro-analytic detection of lead in bismuth. E. Schweitzer. *Z. anorg. u. allg. Chem.*, Vol. 165 (4), September 10, pp. 364-370 (in German).
- CORROSION.**—The corrosion of metals as an electrochemical problem. A. Thiel. *Z. Electrochem.*, September, pp. 370-388 (in German).
- Paradox of corrosion and protective film theory. T. Fujihara. *Ind. Eng. Chem.*, September 1, pp. 1008-1009.
- GENERAL.**—The treatment of complex raw-speiss. W. F. Kaiser. *Continental Chem. Met. Eng.*, July, pp. 195-198; August, pp. 238-242 (in English).
- The electrical precipitation of metal-containing dusts from industrial gases. W. Deutsch. *Metall. u. Erz*, August, Vol. 24 (15), pp. 356-364 (in German).
- Modern furnaces and heat treating methods. E. F. Davies. *Trans. Amer. Soc. Steel Treating*, August, pp. 291-302. A practical discussion of the methods which are in use in many factories in the heating of steel parts for forging, hardening, and tempering. A discussion of the merits of the different methods and types of furnaces used in heating metals is given at length.
- The magnetic transformations of ferromagnetic metals. R. Ruer. *Z. anorg. u. allg. Chem.*, August 19, pp. 142-148 (in German).
- The distortion of crystals of aluminium under compression. II. Distortion by double slipping and changes in orientation of crystal axes during compression. III. Measurements of stress. G. I. Taylor. *Proc. Roy. Soc. A.*, September 1, pp. 16-38, 39-60.
- The magnetic susceptibility of some binary alloys. J. F. Spencer and M. E. John. *Proc. Roy. Soc. A.*, September 1, pp. 61-72.
- The occurrence of the platinum metals. J. L. Howe. *Science*, September 2, pp. 220-221.
- The crystallisation and structure of metals and alloys. A. Portevin. *Bull. Soc. Chim.*, August, pp. 961-987 (in French).
- The influence of sulphur on copper. P. Siebe. *Z. Metallkunde*, August, pp. 311-315. The influence of Cu_2S on some mechanical and technical properties of electrolytic copper. Comparative experiments concerning the influence of SO_2 and Cu_2S , as well as Cu_2S and Cu_2O , on the properties of the copper. Softness of sulphur-containing copper (in German).
- The practical applications of recrystallisation. M. von Schwarz. *Z. Metallkunde*, August, pp. 321-324 (in German).
- The difference between the nuclear and surface zones of drawn wires. E. Schmid and G. Wassermann. *Z. Metallkunde*, August, pp. 325-327 (in German).
- Polishing and etching lead, tin, and some of their alloys for microscopic examination. J. R. Vilella and D. Beregekoff. *Ind. Eng. Chem.*, September 1, pp. 1049-1052.
- IRON AND STEEL.**—Investigations of equilibrium in the reduction, oxidation, and carburisation processes in iron. II. R. Schlenck. *Z. anorganische u. allgemeine Chem.*, August 5, pp. 313-325 (in German).
- Cold hardening by compression and the fragility of steel. The existence of a limit of fragility. P. Dejean. *Revue de Metallurgie*, July, pp. 415-417 (in French).
- Increasing the output in quality alloy steelworks. P. Eyer mann. *Continental Chem. Met. Eng.*, August, pp. 227-231 (in English).
- The influence of silicon, nickel, chromium, and tungsten on the hardening of tool-steel. W. Haufe. *Stahl u. Eisen*, August 18, pp. 1365-1373 (in German).

Progress in study of normal and abnormal steel. S. Epstein and H. S. Rawdon. *Trans. Amer. Soc. Steel Treating*, September, pp. 337-375. The terms normal and abnormal steel are defined, and the characteristics of the normal and abnormal structure in carburising steel and tool steel are illustrated. It is shown that under certain conditions abnormal steel is more prone to give soft spots than normal, but that with drastic quenching in brine or in a sodium hydroxide solution it is possible completely to prevent the formation of soft spots in both normal and abnormal steel.

Normality of steel. J. D. Gat. *Trans. Amer. Soc. Steel Treating*, September, pp. 376-417. The writer dwells on the properties of "cementitic lining" present in abnormal steels, arriving at the conclusion that resistance to uniform hardening is caused by high oxygen content forming a eutectoid alloy with constituents of austenite.

Effect of temperature on the mechanical and microscopic properties of steel. G. C. Pnester and O. E. Harder. *Trans. Amer. Soc. Steel Treating*, September, pp. 436-445. Gives the results of tests on a quenched 0.29 per cent. carbon steel at temperatures up to 1112° F. (600° C.) and on the same steel as hardened, tempered at temperatures up to 1112° F., and then tested at room temperature. Only tensile strength tests were made at elevated temperatures. Tests at room temperature include hardness and impact toughness.

Case carburisation of production steels by means of salt baths of low cyanide concentration. H. B. Northrup. *Trans. Amer. Soc. Steel Treating*, September, pp. 470-478. Discusses a series of carburising tests made on three different types of steels by means of a molten sodium cyanide bath at 1450° F.

PASSIVITY.—The passivity of metals in anodic polarisation. G. Grube. *Z. Elektrochem.*, September, pp. 389-399 (in German).

The passivity of chromium. W. J. Müller and E. Noack. *Monatshefte*, August 20, pp. 293-313 (in German).

SINGLE METALS.—The properties of pure aluminium. L. Guillet. *Comptes Rendus*, July 18, pp. 163-165 (in French).

Deoxidation of nickel. G. Masing and L. Koch. *Z. Metallkunde*, July, pp. 278-279 (in German). The action of various deoxidising agents on the structure of nickel is explained, and it is shown, in confirmation of the work of the Bureau of Standards, that the brittleness of non-deoxidised nickel is to be referred not to the oxygen, but to the sulphur-content. The differing action of manganese and of magnesium is due to the different forms of their sulphides in the nickel.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

[NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]

BRITISH PLATINUM AND GOLD CORPORATION, LTD., London, E.C. Registered August 25, £2,904 debenture stock, part of £50,000 and premium of 5 per cent.; general charge. *Nil. January 13, 1926.

HEATH (ROBERT) AND LOW MOOR, LTD., Stoke-on-Trent, coal and ironmaster. Registered August 24, £71,450 debentures part of amount already registered; general charge. *£1,071,766. July 28, 1926.

STANDARD STEEL CO., LTD., Croydon. Registered August 18, £7,000 debenture, to A. J. Richards, Arbury, Barlston Old Road, Trentham, and another; general charge. *£22,000. December 31, 1926.

Monthly Metallurgical Section

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NOTICE.—Communications relating to editorial matter for our Monthly Metallurgical Section should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Communications relating to advertisements and other business should be addressed to the Manager. Contributions will be welcomed from correspondents on any points of interest to metallurgists bearing on works practice or current research problems.

The Empire Mining and Metallurgical Congress

By a British Delegate

The following article deals in a very attractive manner with the metallurgical and mineral resources of Canada as revealed by the tours organised in connection with the Empire Mining and Metallurgical Congress. The writer was himself a delegate to the Congress, and his notes will therefore be read with special interest.

MEMBERS of the various constituent institutions taking part in the Second (Triennial) Empire Mining and Metallurgical Congress which recently assembled in Canada have now returned to their widespread homes throughout the world after a tour—or, more correctly, a choice of two tours—embracing most of the important mining districts and metallurgical plants of that great country.

During the four or five weeks they were in the Dominion visits were paid by the delegates to the mines and milling plants in the Porcupine and Kirkland Lake districts of northern Ontario, the output of which, added to that of British Columbia, is expected before many months to win for the Dominion the second place, after South Africa, among the world's producers of gold, of which metal Canada now furnishes 9 per cent. of the world's annual production. The Hollinger mine, at Timmins, which we visited, is strenuously competing with two of the big producers on the Rand for distinction as the world's greatest gold mine.

Nickel

In the Cobalt and South Lorrain districts, close by, we saw the mines which, until British Columbia secured precedence, were the principal contributors to the output which gave Canada 9 per cent. of the world's annual silver production. Within a night's journey, too, we examined many of the nickel mines from which 90 per cent. of the production of the world is secured. At Copper Cliff we saw the smelter which prepares the matte, and a day or two previously at Port Colborne, far south on Lake Erie, the plant where this is electrolytically refined to produce metal nearly 100 per cent. pure. At Coniston, the Mond Nickel Co.'s smelter and sulphuric acid plant was visited, and while in the north country we heard a good deal regarding the great Frood mine, where the two companies expect to extract no less than 100,000,000 tons of high-grade ore—enough to meet for 75 years the present annual consumption of the world. As for lead and zinc, we entered at Kimberley, B.C., the famous Sullivan mine, claimed to be the greatest single producing property in the world; and at Tadanac (Trail) inspected at a somewhat racing speed the Empire's greatest metallurgical plant, which produces 10 per cent. of the world's lead output and nearly that proportion of its zinc.

So far as copper is concerned—the Empire's Achilles heel in the metal world—Canada showed us rapid developments at Rouyn in the new copper-gold-zinc mining region of Quebec, and steady production at Britannia, Copper Mountain, and Trail in British Columbia, as well as at Sudbury in Ontario; and we were told much regarding the expected production from Manitoba and Saskatchewan.

Asbestos and Aluminium

Quebec showed us the open quarries and those dusty mills from which the world derives 85 per cent. of its asbestos; and at Arvida, in the Lake St. John district, we saw a huge plant where the conjunction of cheap hydro-electric power and bauxite sea-borne up the Saguenay River from British Guiana is expected within the next two or three years to bring about a production of aluminium equal to 90 per cent. of the present consumption of the world. Here a million pounds of pig aluminium is being turned out weekly, and the plant awaits the completion of the Chute à Caron power

station, with its ten huge 80,000 k.w. generating units, to enable it to reach an annual production of 180,000 tons. When this point is reached the Aluminium Co. of Canada will at the same time be the world's largest power producer and user, developing 1,340,000 horse power in the Isle Maligne and Chute à Caron plants, nearly all for its own purposes, though contracts have been made for long term transmission to the Shawinigan Water and Power Co. and to local paper mills.

Coal, of which commodity Canada claims 75 per cent. of the Empire's known reserves, showed itself to us in the mountains of British Columbia and Alberta, in deep levels or in open cuttings; in the lignite mines and briquetting plant of southern Saskatchewan; and in the submarine collieries of Cape Breton Island, where we also saw what is claimed to be the Empire's greatest steel industry based on purely British materials. Petroleum, proving that oil and water will not mix, hid itself from the Congress with the plea that on the day of our proposed visit the torrential rain had rendered impassable the earth roads in the Turner Valley (Alberta).

Proposed Review of Imperial Resources

Apart from the masterly presidential review of the Empire's mineral situation by Sir Robert Horne, the principal subject for discussion at the Congress was the proposal put forth on behalf of the Institution of Mining and Metallurgy in Great Britain calling upon the Empire Council of Mining and Metallurgical Institutions to secure the setting up in each Dominion and larger Colony of committees of technical experts charged with the review of the mineral resources of smelting and refining capabilities of their respective countries. Such a review is held to be desirable by reason of the fact that in many of the Colonies, at any rate, no complete geological survey has ever been attempted, and that everywhere the ordinary governmental statistics of production and movement lack data indispensable to the formation of a national or imperial economic policy by which to safeguard industries against exploitation by foreign monopolies or to provide against many of the well-remembered difficulties experienced in war-time by the munition and other metal and chemical-using industries.

Published statistics, it is contended, dealing as they do only with producing properties, can give only a very unreliable indication of the capabilities for mineral production from mines which are abandoned, undeveloped and only partially worked for reasons connected with price levels, transportation, power supply, lack of capital, labour shortage or the absence of reasonable governmental encouragement. Sir Thomas Holland's own paper was accompanied by one by Sir Richard Redmayne, describing what is already being attempted in this direction by the Mineral Resources Department of the Imperial Institute, and by three model reviews prepared by the Imperial Institute and dealing respectively with Empire Mining Laws, Mica, and Tin.

How far the technical organisations of the Empire can actually assist in research of this kind is perhaps open to question, but there is no doubt that an intelligently directed public opinion even in the best organised Dominions, like Canada, could do much to encourage the collection and publication of much better co-ordinated data than at present exist regarding the possible sources of mineral production not

yet fully exploited. Geological surveying and research work on mining and metallurgical problems is throughout the Empire conditioned by the amount of funds available, and in

some of the Colonies the setting up of a geological survey is opposed by agrarian interests which fear the effects of mining industries upon a restricted labour supply.

The Use of Inhibitors in Metal Pickling

(From a Correspondent)

In the operations of manufacture of ferrous and non-ferrous metals and alloys, subsequent to the actual production either by reduction or synthetic processes, one or more pickling operations constitute in many cases a necessary part of the procedure. Pickling is essentially a cleaning operation, and normally consists of an immersion of the material in an acid bath subsequent to annealing, with the object of removing adherent scale or oxide resulting from the latter treatment. Very often cleaning in the form of pickling is absolutely essential before further operations, such as drawing, can be carried out. The term pickling has also been used to cover a similar operation, the object of which is somewhat different from cleaning by oxide or scale removal. This process, which is largely used in non-ferrous work, is also termed bright-dipping, and consists of immersing the metal or alloy for a short time in a fairly strong acid bath, usually of chromic or nitric acid, both to effect further cleaning and to impart a bright finish. Bright-dipping is not a substitute for pickling, and where it is carried out it is usually done after an ordinary pickling, and generally at the end of the manufacturing operations, since the finish so obtained is that desired on the completed product. Bright-dipping can, of course, be used simply as an extra cleaning before still further surface treatments.

The readiness with which some portions of scale become detached from a piece of annealed metal, and the provoking tenacity with which other portions of scale adhere, are phenomena well known to those concerned with pickling. This feature, however, is also of economic significance, especially in works where much pickling forms a necessary part of the manufacturing operations. Ordinary pickling, for which dilute sulphuric acid is very generally used, usually succeeds in removing the bulk of the scale or oxide in a reasonably short time, the actual time depending chiefly on the acid strength, the temperature of the bath, and the nature of the metal. It is very often found that to remove residual spots and patches of scale an extended immersion of undesirable duration is necessary. This is unsatisfactory in very many ways, as, for example, the expenditure of time with possible delay of oncoming work and consequent dislocation, unnecessary expenditure of acid on metal already freed from oxide scale, and the undesirable waste of metal by solution in this manner.

Control of Pickling Operations

It is not surprising, therefore, that expedients were resorted to in an endeavour to control the action of the acid in pickling, especially to concentrate its activities on the scale and not on cleaned exposed metal, and thus to reduce acid consumption and metal loss. It has long been known that the addition of certain substances to acid baths greatly decreases the rate of attack of acid on metals without appreciably diminishing the rate of solution of scale or oxide. Such substances, which are usually of an organic nature, are called inhibitors, and have been used in industrial pickling operations for many years. Very little information has been published concerning the nature and action of inhibitors, but in a paper recently read by F. N. Speller and E. L. Chappell at the Cleveland meeting of the American Institute of Chemical Engineers some very interesting and important data are given. As illustrating the primary function of inhibitors, that is, diminution of the rate of acid attack on the metal, the case of the sulphuric acid pickling of steel pipe is given. With an acid concentration of 34 per cent. and a temperature of 25° C., 6 c.c. of hydrogen are given off from 1 square cm. of steel surface, through solution of the metal, in about thirteen hours; whereas if 1 per cent. of an inhibitor is added 1,350 hours elapse before a similar amount of hydrogen is evolved.

A very large number of substances have been used as inhibitors, including arsenic compounds, cyanides, glue, flour, and formaldehyde. A very wide variety of organic substances have been found to act effectively, and certain

data given in the paper cited do not indicate any definite relation between chemical structure or properties and the effectiveness of the inhibitor, but the increasing inhibitory effectiveness of the series aniline, pyridine, quinoline, and quinoline ethiodide is marked, and might be considered as increasing with basicity or/and molecular weight. Several proprietary compounds have been introduced as inhibitors. These include an acid extract of coal tar, high in nitrogen content, an inhibitor prepared from slaughter-house waste by sulphonation, and a sludge from coal-tar treatment. Size or glue, mouldy flour and bran are also used. Many organic waste materials are useful in this connection; for example, the acid sludges which are formed during the sulphuric acid washing of petroleum and coal tar hydrocarbons possess useful inhibitory properties.

Electrochemical Explanation of the Process

Inhibitors have a strong electrochemical effect in raising the hydrogen overvoltage, and their action may be attributed to the formation over the bare cathodic steel of a film which prevents the ready evolution of hydrogen. The rate of acid attack on metals increases with temperature, other conditions being constant, whether the acid contains inhibitors or not. At temperatures much above normal there is a tendency for inhibitors to break down chemically, the temperature in question being different for different inhibitors. In general the first small additions of an inhibitor (fractions of 1 per cent. very often) to an acid pickling bath effect a very marked decrease in the rate of hydrogen evolution, while further additions afford little practical advantage. The chief advantages attendant upon the use of inhibitors are the reduction in the waste of metal and acid, the preservation of metal surfaces, avoidance of the "hydrogen embrittlement" of wire, and the reduction of acid fumes and vapour carried into the atmosphere by liberated hydrogen.

The results of laboratory experiments discussed in the paper show that in one case, where 6 per cent. sulphuric acid was being used to pickle steel, thirty times as much metal and acid were used up when no inhibitor was present as when 1 gram of nitrogen bases per litre of pickling solution was added. In another experiment with 3 per cent. sulphuric acid as pickling medium, and at a somewhat higher temperature, the presence of an inhibitor cut down the amount of acid and metal used to one-eighth of its previous value. In this case the inhibitor consisted of 3.7 grams of acid sludge per litre of pickling solution. Results obtained on plant and laboratory tests to determine the acid consumption in pipe pickling show that large variations occur in acid consumption with or without the use of inhibitors (indicating the advantage to be gained by careful practice), and also that considerable acid saving can be effected by the use of inhibitors.

British Metal Co.'s Copper Production

An announcement has been made concerning the disposal of blister copper by Noranda Mines, Ltd. The British Metals Co. have completed an arrangement with Noranda whereby they will secure the entire output over a term of years at a sliding price scale. The scale of Noranda's blister copper was arranged after keen competition between the various refining companies. About 3,000,000 pounds monthly will be taken at the outset.

A New Iron and Steel Journal

PUBLISHED by the Louis Cassier Co., Ltd., there has recently appeared the first number of a new monthly journal known as *The Iron and Steel Industry and British Foundryman*. Formerly, the subject of iron and steel was dealt with in a special supplement of *The Metal Industry*. This supplement has now been transformed into the new separate journal.

Heat Treatment of Steel

Importance of Exact Control

WHEN it is desired to change the physical properties of steel to meet given conditions, this is usually accomplished through heat treatment. This treatment should yield the exact structure required without external changes, such as distortion, breakage, decarbonisation or scale. Such external changes may mean total loss or require corrections that are difficult and costly. Since the application of heat is a cause for any or all of these modifications, it is necessary in practice to neutralise or balance all undesired forms of change and at the same time to establish an ideal condition under which the change desired shall take place. It is therefore highly profitable to consider certain of the simple principles through an understanding of which the causes of the various changes may be clearly separated.

Hardening with Exactness

All heat treatment is based upon the phenomenon that, when steel is heated, there occur certain changes within its structure, the temperatures at which these changes take place being known as critical temperatures or critical points. Where a tool or other steel part must possess a given hardness, ductility, elastic limit, and other physical properties, it is heated somewhat beyond a critical point that will produce these properties, and after quenching it will retain them at working temperatures. But these physical properties depend not alone upon the temperature from which the metal is quenched. They are governed also by the rate of heating, and in some cases by the time taken to pass through the critical points or the so-called critical range.

We are commonly concerned with the hardening of various tools, such as punches and dies, heading dies, etc., and with that of finished parts such as gears. The finished tool or part must usually be transformed from a soft or annealed state to one of sufficient hardness, tensile strength, and other physical properties to make possible the longest life in the performance of its duty. It must be heated, at a predetermined rate, to an exact point beyond the critical temperature to control the structure, and quenched in some medium that will "freeze" the then existing structure of the steel into permanence. The ideal conditions for correct hardening may be classed under the following three heads: absolute control of the quenching point; of the rate and uniformity of heating; and of the furnace atmosphere.

The Hump Method of Hardening

The Hump method for the heat treatment of steel, covered by U.S. Patent No. 1,188,128, has been developed and the Hump electric furnace equipment designed to meet as nearly as possible the ideal conditions for the hardening of steel. The method requires for its operation a simple, easily handled and compact group of equipment: a single point recording potentiometer, an electric furnace with manual control equipment, and an immediately adjacent tank for quenching. The recording instrument gives clearly, and by an unmistakable indication in the form of a "hump" in its recorded curve, the time, rather than the temperature, at which the tool or part reaches its critical or change point. Quenching then takes place at a predetermined interval after the "hump" appears, so that it and all subsequent operations rest upon the solid foundation of exact knowledge as to the interval between the critical point and the quench. Control of the quenching point is thereby placed definitely in the operator's hands. In addition to this, the Hump method provides a uniformly heated electric furnace and equipment for controlling its rate of heating and that of the work. It also provides a furnace atmosphere which is constant and with a minimum amount of oxygen.

The possible applications of the method are obviously innumerable, as it applies equally well no matter what steel is used, with the exception of high-speed steel. The necessary equipment, which has been developed by the Leeds and Northrup Co., is supplied by the Integra Co., Ltd., of 183, Broad Street, Birmingham, who have issued an illustrated monograph on the subject entitled "The Hump Method for Heat Treatment of Steel." Examples are there given of the application of the method in a few of the many possible instances, such as blanking dies and cutting tools; forming punches, dies

and moulds; stamping dies; cold heading dies; and gear hardening. The monograph also gives details of size, price, etc., of the requisite furnace, recorder, etc.

Some Advantages of the Method

Some of the advantages obtained by the proper application of the Hump method of hardening, whether for tools or parts, are: Increase in the average life of tools and parts amounting to as much as 400 per cent.; elimination of breakage in hardening; practical elimination of distortion, and therefore of grinding or stoning; clean work—free from decarbonisation; the equipment is flexible, and can be added to from time to time without the installation of accessory equipment; hardening can be put in the "line of production," this being possible because there is practically no excess heat present; better and more pleasant working conditions; and a complete record of the hardening operation which is authentic, being based upon the action of the steel itself and not upon the accuracy of the human eye or pyrometer.

Stress in Electro-deposited Metals

A Paper before the Electroplaters' Society

THE opening meeting of the third session of the Electroplaters' and Depositors' Technical Society took place on Wednesday, October 19, at Northampton Polytechnic Institute, London, when Mr. R. H. T. Barklie, M.Sc., A.I.C., delivered a paper on "Stress in Electro-deposited Metals."

Mr. Barklie likened a layer of electro-deposited nickel on a rigid cathode to a series of sheets of rubber placed one over the other, the sheets counting upwards being stretched to an increasing degree; the resultant stress militates against the adhesion and the ultimate possible thickness of the deposit. Thus, the stress was of importance in "building up" worn machine parts by electro-deposition, since distortion might occur, and the mechanical strength of the original article be seriously affected. The magnitude of the stress was of a remarkably high order, and as measured by Mills as far back as 1877, was found to be as follows:—

		Atmospheres.
Cadmium.....	Distension	2'3
Zinc		6'2
Nickel		19'2
Iron	Compression.....	18'2
Silver		66'4
Copper		103'0

Details of the bath used were not known in these cases, but Stoney, in 1909, using a solution of double nickel salts at a current of 0.05-0.11 amp. on an area 102 mm. by 12 mm., obtained a mean tension of 18.1 tons per sq. inch at ordinary temperature, this being reduced to 9.9 tons on raising the temperature to 85° C.

Reduction of the Stress

The reduction of the stress might also be effected by reducing the amount of co-deposited hydrogen. This could be done by adding oxidising agents to the bath, e.g., potassium chlorate, hydrogen peroxide, and cinnamic acid. Decreasing acidity and ferrous iron also had their effect. Again, the use of superposed alternating currents on the direct current used to deposit nickel was found to diminish the contraction tendency of the electro-deposit to a very considerable extent.

The nature of the stress had been accounted for by Kohlschutter as being due to the dispersion of the metal on a continuous hydrogen phase, a process of grain-growth being supposed to take place, which was accompanied by contraction. According to Blum and Rawdon, however, the contraction tendency was due to cohesion between the crystal faces of the electro-deposit, conditions giving small crystal size, giving a high value for the contraction tendency.

Discussion

In the discussion which followed many interesting points were raised. Thus, it was pointed out that although the figure for the stress in deposited copper was so high, in practice nickel was found to give far more trouble. The stress in thin deposits was comparatively unimportant, but in thicker deposits, as in electrotypes, the matter was serious, and the use of nickel was therefore restricted in electrotyping. It was difficult to get rid of the strain after deposition, heat treatment being unsatisfactory, hence steps for its diminution must be taken during the process of electro-deposition.

Metallurgical Topics: Monthly Notes and Comments

From Our Own Correspondents

Aluminium Bronzes

ALUMINIUM bronzes—which, of course, are not bronzes at all—constitute an important series of alloys which are attracting a good deal of attention of late. J. Bouloires has published the results of his researches on the group containing from 80 to 95 per cent. of copper. They were prepared by melting the copper in graphite crucibles in a Meker furnace and raising the temperature of the molten metal to 1100° C. The aluminium, which was of the commercially pure variety, was thrown into the melt, a little at a time, in the form of rods. The copper was electrolytic. The resulting "bronzes" contained about 1 per cent. of iron plus silicon derived from the aluminium. The cooling curves and transformation points of the alloys were carefully studied. Some of the results recorded in respect of the electrical properties of these alloys were peculiar. The resistance varies directly in proportion to the aluminium present, and the influence of rapid cooling is particularly marked. The alloys may be regarded as having the property of air-hardening. With 86-86 per cent. of copper a transformation occurs at temperatures above 530° C. (the eutectoid temperature) which has not hitherto been recorded. At these temperatures the thermo-electric properties are at a maximum. Below them, they fall rapidly. The Brinell hardness increases rapidly with increase of aluminium content; with rapid quenching from a temperature of 500° C. the maximum hardness is developed by an alloy containing only 80 per cent. of copper. This alloy is over six times as hard as the highest proportion copper alloy, which contained 94.93 per cent. of copper. The hardening effect of aluminium in this series of alloys is therefore considerable and well-defined.

Nomenclature of Alloys

THE Institute of Metals embarked recently on the strenuous but useful task of drawing up lists of the named alloys, with information respecting their composition, properties, and applications, and equally useful notes as to their manufacturers. It is a very frequent occurrence to be asked for these particulars, which are hardly ever to be found just when they are most wanted. It is not too much to say that there are thousands of proprietary alloys with fanciful names which convey nothing as to either their properties or applications, and a very useful function will have been fulfilled when such lists as the Institute of Metals had in mind become generally available. It is disappointing, therefore, to learn on inquiry that the progress being made is very small. There is a general lack of help and support from the very firms which might be expected to be chiefly concerned, the manufacturers of such alloys themselves. This appears to indicate some failure to appreciate their own best interests, and to afford a further instance of the all too familiar tendency of British manufacturers to hide their light under a bushel. It seems to be rather a work of supererogation to make an alloy and not to make it known, either by advertising it or by supplying particulars to a body like the Institute of Metals which would circulate them for the information of potential customers. The nomenclature of alloys is a confusing subject, as is likewise their classification. In both directions there is room for improvement and systematisation.

Cementation of Ferrous by Non-Ferrous Metals

MR. J. LAISSUS is continuing, in the *Revue de Métallurgie*, his very interesting investigations on the cementation of ferrous metals by non-ferrous metals, and has recently published details of his experiments on the cementation of pure electrolytic iron, medium steel (0.80 carbon), ordinary eutectoid steel (0.80 carbon) and grey pig iron. The metals employed as cements were a 41 per cent. ferro-vanadium; pure cobalt; a 71.85 per cent. ferro-molybdenum, and a ferro-tantalum containing 29.26 per cent. of tantalum. In the case of the vanadium experiments, five hours heating at temperatures ranging for each period from 900° to 1200° C., gave no appreciable thickness of case, when electrolytic iron was employed, and the thickness of case was far greater with low carbon steel than medium or high carbon steel, results that, to say the least, are anomalous.

When cobalt was employed, the superficial case was very thin, and scaled readily. Its microscopic structure served to confirm the view that a compound Fe_2Co is formed. Here, again, the electrolytic iron case was the thinnest, although the higher carbon steels were less permeated by cobalt than the mild steel. Treatment with vanadium and with chromium had, in each instance, an appreciable effect in increasing the hardness of the case and in reducing the corrodibility of the samples. When molybdenum and tantalum were used as cements, the case which formed on electrolytic iron was as thick—and in the experiment with tantalum, thicker—as when carbon was present, and once again it was found that the higher the carbon the thinner the case formed. Both molybdenum and cobalt confer the property of enabling the sample cemented by them to take a high polish, and also help to increase its resistance to corrosive influences.

Corrosion Testing

IT is customary, in the commercial testing of iron, steel, and, indeed, non-ferrous metals as well, to exercise a good deal of discrimination to decide upon a representative sample. A tensile test is a serious matter; large contracts may depend on the issue. Corrosion tests have, as a rule, few vital consequences, and are comparatively seldom specified. No less care in the selection of samples really representative of the material should, however, be exercised, or a given material may be branded as being prone to corrosion on very inconclusive grounds simply because the particular specimen was of an inferior quality, and therefore not properly representative of the bulk. It is doubtful whether any really useful conclusions are to be drawn from corrosion tests as usually carried out. Time tests under actual service conditions may afford valuable indications, but of the acceleration test there is little good to be said. In practice, materials are not subject to accelerated corrosive influences. No chemist or physicist would attempt seriously to correlate the behaviour of a metal in an acid solution of, say, 10 per cent. strength, with its behaviour in an acid solution of 20 per cent. strength and expect to find it corroding (entering into solution?) at precisely double the rate. These things do not happen, in reality, however much they may be assumed to do so by those who institute differential "acid" tests of this nature.

Confused Views as to Corrosion

THERE is still a good deal of confusion respecting what corrosion tests may be expected to show in the way of really tangible results. There is an undefined critical limit to what a metal will stand, in the way of corrosion, just as there is in fatigue testing. A metal may stand up to corrosive influences for some critical period, and once that time limit of corrosive endurance has been exceeded, it may commence to corrode at a far higher rate than before, or, conversely, it may withstand gradually increasing corrosive influences, and fail suddenly when they exceed a limiting concentration. In practice there are so many other factors at work that a practical result is almost impossible of accomplishment in corrosion-resistance testing. There is the very important influence of erosion, by wind or water-borne particles; alternations of temperature; and a host of other conditions. These, it is not too much to say, are never taken into account by the accelerated test, and even the time test is unsatisfactory unless the material under test is subjected throughout the whole period to the identical conditions it would have to meet in practice. Finally, bearing in mind what has been said about critical corrosion, it should be borne in mind that not even comparative tests on dissimilar metals can be deemed to give, invariably, reliable "comparative" results. The way a number of dissimilar metals behave under x set of conditions is little or no criterion of how they will behave, relatively, under y conditions. Their critical endurance limits will vary too much for that.

Tests on "Protected" Metals

THE foregoing remarks apply with even greater force to coated metals, whether plated, rolled on, sprayed, hot tinned or galvanised, oiled, painted, or enamelled. The thickness

of the coating probably plays a less important part than the nature of its surface. It was found, in some recent investigations on painted surfaces, that a highly enamelled and glossy surface had a greater affinity for catching and retaining dirt than a matt surface, and consequently wore worse, a finding quite opposed to popular belief. A highly polished metal surface condenses moisture more readily than a less highly polished surface. Unless the polishing be carried to the point of the "flowed skin" that Beilby described, mere polish may be detrimental. It is often found that such surfaces soon acquire a bloom—like nickel-plating—which is unsightly, and may, in some cases, help corrosion. Corrosion tests that do not take into consideration all these and many other factors, yield very little really useful information. In some recently published results a metal which has, in practice, proved over and over again its valuable non-corroding properties, has been pilloried as inferior, in those properties, to several other metals notoriously inferior to it. On investigation it was found that the single sample selected was a thoroughly bad one, and in no way representative of the material as habitually marketed. In tests intended for widespread publication there is always a danger in selecting as representative a single sample of any class of metal. In the case referred to, not only was this done, but no attempt was apparently made to ascertain whether the sample selected was a good or a bad one of its class. Many people are impatient of corrosion tests, as it is, and a few more experiences of this nature will confirm them in their disinclination to accept the results of such tests as having any real value in practice.

Dorman, Long's Indian Development

DORMAN, LONG AND CO., LTD., the Tees-side steel manufacturers, have decided to extend their business interests in India, and propose to open constructional and bridge building shops there in the near future. Sir Arthur Dorman, chairman of the company, is visiting India on business connected with the scheme. The location of the shops has not yet been definitely decided, but presumably they will be either at Bombay or Calcutta. The company has interests in many parts of the world, and extensive business connections in India, where the market potentialities for steel are immense. Since the war Dorman, Long and Co., through alliances with old-established and sound engineering undertakings abroad, have secured extensive outlets for their products. In pursuit of this policy they acquired a large interest in Braithwaite and Co., thus securing increased opportunities in the East. In obtaining control of the British Structural Steel Co. of Buenos Ayres, they have a useful outlet in South America; whilst their close connection with Wade and Dorman has enabled them to enlarge their South African interests.

The decision of the Government of India to carry out the main recommendations of the Indian Tariff Board, giving a preferential tariff to British steel, has been of great encouragement to British steel manufacturers. India already takes large quantities of British steel, and for many months the largest tonnage shipped from the Tees to overseas countries has been destined for India. It is believed to be the intention of the Government of India in respect of certain classes of manufactured steel to restrict tenders to India alone, and to specify that the steel shall be fabricated in the country. a policy very similar to that adopted in Australia.

International Wire Rod Association

THE British Consul-General at Cologne states that, according to the *Kölnische Zeitung*, the negotiations between Germany, France, and Luxemburg for the formation of an International Wire Rod Association have been practically concluded. Within the Belgian group differences of opinion still exist, which, however, are expected to be removed shortly, making it possible for the association to be definitely formed. It is stated from Brussels that the yearly participation quota of the International Wire Rod Association has been fixed as follows:—Germany, one million tons; France, 400,000 tons; Belgium, 260,000 to 280,000 tons; and Luxemburg, 120,000 tons. The production of the Saar is included as to 50 per cent. in the German and 50 per cent. in the French quota.

Vickers, Ltd., and the Schneider Cup

SIR SAMUEL HOARE, referring to Flight-Lieutenant Webster's victory in the Schneider Trophy Race, when he attained the phenomenal speed of 284.14 m.p.h., described this British success as providing one more proof of the unsurpassed excellence of British personnel and materials. A notable contribution both of material and workmanship to this success was that of Vickers, Ltd., who were responsible for the steel and manufacture of the crankshaft and the connecting rods of the Napier "Lion" engine installed in the Supermarine Napier S5. This constitutes the fourth record-breaking achievement during the current year in which Vickers steels have proved their incontestable excellence. It may be recalled that the frame, gears, axles, shafts, etc., of Captain Malcolm Campbell's "Bluebird" car, with which he achieved a speed of 173.883 m.p.h., were made of Vickers steels, as were also all the vital parts of Major Segrave's 1,000 h.p. Sunbeam car, with which he set up a world's record speed of 203.841 m.p.h.

Chemical and Metallurgical Corporation Developments

THE following is a digest of a circular sent to the shareholders in the Chemical and Metallurgical Corporation:—Shareholders will remember that when it was decided to acquire a site at Runcorn and erect the plant for the treatment of complex ores, particularly those carrying lead and zinc, under the special processes controlled by the company, the capital then at their disposal was only sufficient to cover the cost of reagent plants and equipment for the separation of the metals and the conversion of the lead residues into metallic lead or compounds, it having been the intention to dispose of the zinc residues to continental zinc smelters. As the necessary capital for the erection of an electrolytic zinc refinery can now be provided under arrangements with certain English groups controlling the supply of lead zinc ores, the directors have decided, when a complete study of the electrolytic zinc development has been made in America and elsewhere, to erect a modern electrolytic zinc refinery in Europe, so that the company will be able to reap the full benefit of the treatment under its patented processes of all the constituents of the ores coming to their works. As indicated by the chairman at the last meeting, the company has evolved a very satisfactory process for the treatment of the South African platinum-copper-nickel concentrates, and since then a pilot plant has been in successful operation at the Stratford works. It is now proposed to erect at Runcorn a plant for the commercial treatment of these concentrates.

To carry out this programme will call for further capital. On June 9, 1925, a special resolution was passed providing that no issue of capital beyond 5,000,000 new Ordinary shares could be made without the authority of a general meeting, and the directors do not think, in shareholders' interests, that there should now be any such limitation. They therefore propose to obtain shareholders' sanction to deal with the entire remaining unissued capital of the company at such price and in such amounts at their discretion. The directors have entered into a negotiation with a banking house in the City, associated with their class of business, to issue to it an important share holding in the company. The transaction carries with it an obligation to elect to the board a nominee of the bank who has special knowledge of hydro-metallurgy.

At a meeting to be held on November 7, the directors will ask the shareholders to sanction the issue of any of the 9,500,000 unissued 2s. ordinary shares of the company.

American Monopoly of Russian Aluminium

IT is reported that an agreement has been made between the Aluminium Co. of America and the Russian Government whereby the Americans are given the sole right to erect plant for the production of aluminium in Russia. The concession will continue for 30 to 50 years. Various projects are afoot. The exploitation of the bauxite beds at Tichwinsk, near Leningrad, which are estimated to contain 4,000,000 tons of bauxite, comes first. Two factories (one with a capacity of 1,200 tons of aluminium per annum) are to be erected for the utilisation of the bauxite. The present demands of Russia are computed at 6,500 to 10,000 tons of aluminium annually, among other purposes for production of aeroplanes.

Trade, Commerce, Finance : The Month in Review

From Our Northern Correspondent

It is disappointing to report that, although we are now well into the last quarter of the year, there is no sign of any actual improvement in the iron and steel trade, such as one might reasonably expect at this time. It has become part of the accepted order of things that the closing months of the year witness a revival from the sluggish condition which characterises the trade during the holiday months, but this year is proving an exception to the rule. Wherever one goes, the same story is told. Order books are shrunken, new orders are scarce, and the mills are being carried on from week to week without any forward prospect and, in many cases, with not even a full week's work ahead. The opinion is freely expressed that there will be nothing done until the spring of next year and that that means there will be no improvement until the following autumn. Altogether it is a dispiriting outlook. Several of the steel works have had to close down one or more of their departments owing to lack of orders, and those which hitherto have had a full share of work are now feeling the pinch and are getting very anxious about the future.

Excessive Optimism

It did seem a few weeks ago that the market was brightening, and there were hopes that the more cheerful tone manifested would soon lead to increased business. The papers talked of a general improvement in trade, and in speeches made by prominent men on various occasions the same optimism prevailed. Even at the Cutlers' Feast in Sheffield last week we were assured by some of the speakers that the trade of the country was better than it had been, but that opinion was not shared by Sir Auckland Geddes, particularly with regard to the iron and steel trade, and he warned his hearers not to be misled by optimistic reports. The steel trade is not better and it is doubtful whether it is holding its own; indeed, unless measures are conceived and adopted for providing the much needed assistance it is feared that the trade will go from bad to worse.

The published reports of some of the large companies which have appeared recently show how unsatisfactory the position is. Ingenious attempts are made to explain away the bad results, but they are not very convincing, and the endeavour to arouse hope for better things in the future is rather vain. It is a weary time for the shareholders and still more so for those who are working hard to carry on these great enterprises in the face of the difficulties which exist.

The Rebate Scheme

It is realised that competition from the Continent is more serious than ever. The rebate scheme, which had the avowed purpose of reducing the amount of foreign steel imported and substituting British steel, has so far not had any noticeable success. It is too early to judge the scheme, as there are still deliveries to be taken from abroad against contracts entered into before the rebate scheme was launched, but the general attitude towards the scheme is one of indifference. It is doubtful whether it can have any real effect on the importation of foreign steel. Probably the great majority of those consumers who take advantage of it are firms whose purchases of foreign steel, if any, amounted to a mere fraction of their total requirements, and the rebate is nothing more nor less than an official reduction of 5s. per ton in the price of the various classes of steel which come within the scope of the scheme. Those firms who had been accustomed to buying a large portion of their steel from abroad are not concerned about the rebate, and its only effect will be to encourage them to use more foreign steel. In some parts of the country, notably in the Midlands, there is very little interest in the scheme. The merchants particularly are inclined to be unfriendly to it, as it places them at a distinct disadvantage. Not only does it mean that they have to disclose their customers to the steel makers, but they are subject to certain restrictions which do not apply to the consumer, and the tendency will be to increase the direct connection between the consumer and the maker, to the exclusion of the merchant.

Increasing Foreign Competition

The menace of foreign competition in special steels to which we referred last month is increasing. It is reported that large stocks of nickel steel from Belgium are now being held in the Midlands, and that stocks are being rapidly built up in other parts. The price is considerably less than that of the home-produced steel, and the quality appears to be giving satisfaction. It will never do for the British makers to allow this and similar sections of the trade to be captured by the foreigner, but short of some form of protection it is difficult to see what can be done. After all, price and quality are the two chief factors in securing orders, and if both are favourable, and prompt delivery can be assured, as is the case when stocks are held, the use of the foreign product is bound to increase. The foreign steel makers are not blind to the importance of the trade in special steels, and they are devoting more and more time and study to their manufacture.

Sales below Cost

Another form of competition to which attention might be directed is one that prevails at home, and that is the practice of certain firms of cutting the price of steel in order to secure business when it is known that the price is much below cost and that losses are being incurred. Instances of this occur every day, and it almost looks as though the works making the biggest loss quote the lowest price. It is a policy of desperation. Apparently the mills are so short of work that orders must be secured at any price, and rather than let the work go to other makers who are better equipped for turning out that particular product, and whose price is within reasonable margin of the cost, they underquote and so force the price down to a level which is well below the cost of any producer. It is an immoral form of competition, and a dog-in-the-manger policy which is only intensifying the plight in which the steel trade finds itself.

The controlled materials, plates, sections, and large bars, are exempt from this competition, but the outside materials, particularly billets and small bars, are suffering so badly that the orders are not worth having, except to the re-rollers who use foreign steel. Sales of billets by a British maker were made in the Birmingham district at £5 16s. 3d. and £5 17s. 6d., and small bars are being sold at prices varying from £7 to £7 10s. per ton delivered. Such prices are no use to the makers who roll from their own steel, and the only way to meet them is to use foreign steel. No wonder that one company has decided to discontinue the manufacture of steel and become a re-roller only, using continental billets! That is about the only way to make a profit at present prices.

Market Conditions

There is not much of interest to report in the general market conditions. Pig iron seems to be the strongest section of the market and a slight upward movement in price has resulted in rather more buying, although the improvement has now worked itself out, and there is a tendency to fall back to the old price. The buying is due to the fact that stocks at consumers' works are low, and the output from the furnaces has diminished. The bar iron trade is very quiet, and like the steel trade is suffering from want of orders. There is no life in the market for steel and the only buying that takes place is for present requirements. The expectations of increased business after the Motor Show have not yet been fulfilled. There is some doubt as to the accuracy of the reports which told of the heavy business done at the Show. Possibly this branch of the trade will revive in a few weeks' time; the sooner the better, as it is one of the best markets for the steel makers.

The production figures for September show a decline in the number of blast furnaces at work, there being five fewer in blast at the end of the month than at the beginning. The output of pig iron was 591,500 tons compared with 596,100 tons in August. The production of steel in September amounted to 777,000 tons compared with 643,100 tons in August. These figures compare with 949,600 tons for March last, when all the works were in full swing owing to the orders accumulated during the coal strike.

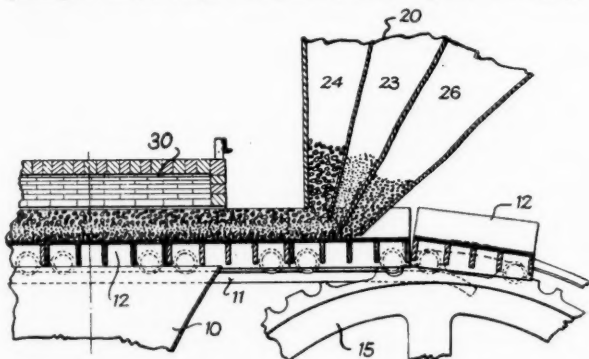
Some Inventions of the Month

By Our Patents Correspondent

Abstracts of other Patents of metallurgical interest will be found in our Patent Literature published weekly in THE CHEMICAL AGE.

Calcing Carbonates, etc.

It is difficult to calcine small particles of limestone or the like in the usual shaft furnaces, owing to the tendency to pack together, while in rotary furnaces much material is carried away, as dust, owing to the violent agitation. According to a patent by the Dwight and Lloyd Metallurgical Co., New York, U.S.A., the calcination of such a material is effected by spreading it in a shallow layer on a support having gas passages therethrough and passing heated gases through it.



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preferably downwards. An excess of heated gases is maintained above the layer, the pressure below being regulated to draw some gas through at the necessary rate. It is preferred to grade the material so that most of the larger particles of carbonate, etc., are in the upper layers, and also to have a layer of previously burnt material below. The layer of material on the previous support may be advantageously carried continuously through the treatment zone. In the apparatus shown in the figure, material to be burned is fed from the hopper 20 on to a series of pallets 12, having previous bases, and which are propelled by the toothed wheel 15 along rails 11 through the reverberatory arch 30, which is fitted with suitable burners for producing the heated gases. The pressure in the wind box 10 is such as will suffice to draw a suitable amount of the heated bases through the layer of material. The hopper 20 may be divided into a number of parts, 23, 24, 26, so as to enable the layer of material to be graded as desired throughout its thickness. The hopper 26 may supply previously burnt material, which serves to protect the metal parts of the apparatus from the combustion gases. See Patent No. 275,463, having the date November 26, 1926.

Iron and Steel

SILICON iron of very low carbon content is useful in certain parts of electrical apparatus on account of its desirable magnetic properties, namely, high permeability and low hysteresis losses. V. B. Browne, of Tarentum, Pennsylvania, U.S.A., prepares such irons containing over 3 per cent. of silicon and less than 0.03 per cent. of carbon, by first freeing iron from sulphur, phosphorus, and as much carbon as possible by known methods; iron ore is then added until no further reduction takes place, and the metal is transferred to a Bessemer converter containing silica to produce sufficient heat during the subsequent blow, which is continued until practically all the carbon has been removed. The silicon content of the iron is then adjusted by addition of ferrosilicon containing less than 0.2 per cent. of carbon. The product is freed from silica, slag, and other inclusions by storing it for a time in the molten state in a comparatively large receptacle in which the impurities have opportunity to float to the surface; the metal is tapped from time to time and corresponding additions of the carbonless iron made to the bath. Instead of using a Bessemer converter for removing the last part of the carbon, the iron may be directly treated in the furnace in which refining has taken place; pipes are introduced into the molten metal, and air, preferably enriched in oxygen, introduced until all the carbon has been oxidised. See Patent No. 277,537, having the date January 10, 1927.

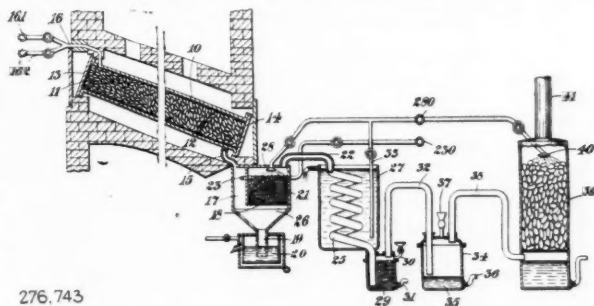
According to a Patent Application by the Friedrich Krupp Akt.-Ges. F. Alfred-Hütte, Rheinhausen, Niederrhein, Germany, when utilising a portion of the waste gases, the blast is supplied at the highest possible temperature, the coke used being correspondingly small; changes in the temperature equilibrium of the processes are corrected by varying the quantity or temperature of the waste gases or by adding oxygen or coal dust thereto. See Patent Application 275,601, having the International Convention date August 6, 1926.

Steel alloys offering great resistance to heat contain 15-25 per cent. of chromium and 15-25 per cent. of nickel, but less than 0.2 per cent. of carbon. See Patent Application 276,317, by F. Krupp Akt.-Ges., Essen, Germany, having the International Convention date August 23, 1926.

In another Patent Application by the same firm there are described low carbon steels resistant to the action of liquids such as boiler-feed water or vapours and gases such as ammonia. The steel in the molten state is so highly deoxidised that subsequent ageing does not cause any substantial decrease in its tenacity; alternatively the solid steel may be heated to 650° C., quenched, and reheated to 750° C. See Patent Application 276,615, having the International Convention date August 27, 1926.

Extracting Tin

ON treating tin ores, tailings, slimes, etc., with hydrochloric acid gas in the presence of a carbonaceous reducing agent the tin can be volatilised and collected as stannous chloride, but is liable to be contaminated with other metal chlorides, such as those of copper, iron, or tungsten, if these metals are present. In a process patented by H. L. Sulman and H. F. K. Picard, of London, this treatment is effected at a temperature, such as 600-700° C., at which the tin is converted into stannous chloride and distilled over free from iron, copper, tungsten, etc. In the earlier stages of the reaction water vapour should be absent, since it is liable to decompose the stannous chloride. In later stages, however, it may be advantageously introduced in limited amounts, since it will decompose the other metal chlorides produced with formation of hydrochloric acid, the consumption of which is thus correspondingly reduced. The



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carbonaceous reducing agent is preferably one, such as bituminous coal, capable of intumescent, so that a porous mass readily penetrated by the hydrochloric acid gas results during the preliminary coking. The walls of the apparatus used should be impervious to gases since the ingress of air is highly disadvantageous. A suitable form of apparatus is shown in the figure. The material is charged into the inclined cast iron retort 10, which has a lining 12 of vitreous acid-resisting silicate enamel, an inlet 16 for hydrochloric acid gas or steam, and an outlet 15 leading to a condenser 26. The latter is provided with an inlet 23 for steam, and a water seal 20 in which most of the stannous chloride dissolves; the remainder, which is usually in the form of a mist or fume, is trapped in the charcoal 21, which is supported on a false bottom 18, and washed when necessary by a spray of water 28. The gas leaving the condenser is cooled in a worm 25 prior to entering a small stannic chloride condenser 29, packed with inert material; it is supplied with concentrated hydrochloric acid. The remaining part of the apparatus consists of a hydrochloric acid absorber 34 and scrubbing tower 39. The solution of stannous chloride collected in the condenser 26 may be either electrolysed for the production of metallic tin or evaporated for production of stannous chloride crystals, the product being free from other metals and arsenic. See Patent No. 276,743, having the date June 2, 1926.

Current Articles Worth Noting

We give below a brief index to current articles in the technical Press dealing with metallurgical subjects.

ALLOYS.—The uniformity of brass. E. R. Thews. *Brass World*, September, pp. 289-292. Small fluctuations of main constituents are strongly influenced by even small quantities of impurities. Uniformity is obtained by melting in large units.

Contribution to the study of printing alloys and of lead and tin metals. A. Travers and Houot. *Rev. de Metallurgie*, September, pp. 541-554 (in French).

Magnesium and its alloys. J. A. Gann and A. W. Winston. *Ind. Eng. Chem.*, October 1, pp. 1193-1201. Discusses the relationship between composition, microstructure, and properties of magnesium base alloys, and the Dowmetal alloys. The foundry practice, which is disclosed, is said to be different from that used elsewhere, being based on the use of a flux.

ANALYSIS.—New processes for the determination of traces of certain impurities in lead. B. S. Evans. *Analyst*, October, pp. 565-572.

A method for the determination of antimony in white metals, etc. H. R. Fitter. *J.S.C.I.*, October 21, p. 414T.

CORROSION.—The theory of metallic corrosion in the light of quantitative measurements. G. D. Bengough, J. M. Stuart, and A. R. Lee. *Proc. Roy. Soc. A.*, October 1, pp. 425-467.

The effect of certain impurities upon the corrosion of zinc. II. Atmospheric corrosion. W. S. Patterson. *J.S.C.I.*, October 7, pp. 390-396T.

The use of electrolytic deposits of cadmium for the protection of metals and alloys against corrosion. J. Cournot and J. Bary. *Comptes Rendus*, October 17, pp. 773-774 (in French).

GENERAL.—Has pure aluminium an allotropic transformation? M. Haas. *Z. Metallkunde*, October, pp. 404-406 (in German). Describes a dilatometric method of investigation, and the evaluation of the curves obtained. A transformation of pure aluminium could not be found up to 610° C.

Annealing experiments with various metal wires. P. Siebe. *Z. Metallkunde*, October, pp. 385-389 (in German). Annealing experiments in a salt-bath with wires of copper, bronze, brass, aluminium, and iron.

Investigation of the phase diagram of the system copper-nickel. D. Jitsuka. *Z. Metallkunde*, October, pp. 396-403 (in German). The investigation consists of very detailed thermal and micrographic analysis. It deals not only with the equilibria between crystalline phases, but with those between liquidus and solidus. In addition, the volatilisation of zinc in air and in vacuo is investigated.

The films responsible for oxidation tints on metals. U. R. Evans. *Nature*, October 22, p. 584.

The reactions between cuprous sulphide and metallic lead, tin, and especially zinc at melting temperatures. C. Frick. *Metall u. Erz*, October, Vol. 24, part 19, pp. 465-472 (in German). The actions of lead, tin, and zinc on cuprous sulphide have been tested, in view of the work done on the separation of copper from concentrated copper ores by the action of iron. The experiments show that these methods also effected the separation of metallic copper.

The anodic behaviour and the passivity of nickel. W. J. Müller. *Monatshefte*, Vol. 48, part 7, pp. 559-570 (in German).

Rod milling and wire drawing. J. P. Bedson and J. S. G. Primrose. *J. West of Scotland Iron and Steel Inst.*, Vol. 34, part 4, pp. 52-62.

The action of aluminium and zinc on cement. C. R. Platzmann. *Chem.-Zeit.*, October 29, pp. 833-835 (in German).

SINGLE METALS.—Some electrochemical studies of titanium. E. D. Botts and F. C. Krauskopp. *J. Phys. Chem.*, September, pp. 1404-1419.

Germanium. XX. Preparation of fused germanium directly from germanium dioxide. K. M. Tressler and L. M. Dennis. *J. Phys. Chem.*, September, pp. 1429-1432.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

[NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]

ASKERN COAL AND IRON CO., LTD. Registered September 14, £15,300 (not ex.) and £30,000 (not ex.) mortgages to Building Society; charged on lands and messuages at Askern. *£643,069. July 14, 1927.

BETTS (JOHN) AND SONS, LTD., Birmingham, smelters and assayers. Registered October 11, £5,000 mortgage, charged on 61 (and vault in basement) and 62, Eagle Street, London. (Note.—£10,000 debenture dated December 15, 1926, has been postponed in point of charge to this mortgage.) *£10,000. January 8, 1927.

MONDEGO TIN DREDGING CO., LTD., London, E.C. Registered October 1, £5,000 debentures, part of £10,000; general charge. *£22,500. April 26, 1926.

WIDNES FOUNDRY (1925), LTD. Registered September 20, £60,000 debentures, charged on company's land at Widnes, also general charge. *£37,000. December 21, 1926.

WIGPOOL COAL AND IRON CO., LTD., Drybrook. Registered September 24, £5,000 debentures (filed under sec. 93 (3) of the Companies (Consolidation) Act 1908), present issue £2,000; general charge. *£20,000. July 3, 1926.

Satisfactions

BLAENAVON CO., LTD., ironmasters, etc. Satisfactions registered October 15, £500 and £1,106, parts of amount registered August 24, 1911.

YORKSHIRE IRON AND COAL CO., LTD., Leeds. Satisfaction registered October 5, £21,290, part of amount registered July 5, 1901.

Steel from Low-grade Iron Sands

Direct Method of Production

For a great number of years endeavours have been made to evolve a process of steel production which would enable low-grade titaniferous ores and magnetites to be made directly into steel.

Although success has been achieved in laboratory working, the direct method was not used on a commercial scale in Great Britain until 1925, when by what is known as the "Carsil" process an ingot of steel was produced in an electric furnace in one operation from titaniferous iron sands from Java. Practically 100 per cent. utilisation of material is claimed, and the process, which is being developed by the Anglo-American Steel Co., Ltd., of 66, Victoria Street, London, involves the treatment of ores in an electric furnace.

The almost complete utilisation of materials is effected by subsequent treatments of residues from the smelting process. Among the substances which are claimed as by-products of the process are titanium oxalate, titanium nitrate, cements, materials for constructional work, and glass. The steel resulting from the process is claimed to be of superior quality, having a high degree of resistance to fatigue, and resisting heat and corrosion very strongly. Some details of the qualities of the metal are to be found in a paper read by Mr. O. Smalley at a meeting of the Electro-Chemical Institute of Philadelphia on April 28 of this year.

In a rotary fatigue test a British Standard rail, 85 lb. to the yard, rolled from "Carsil" steel made from New Zealand titaniferous iron sands, gave a full 100,000 revolutions with a fibre stress of 20 tons per square inch, a further 50,000 revolutions with 25 tons, another 50,000 revolutions with 30 tons, and a still further 33,030 revolutions with a fibre stress of 35 tons to the square inch.

A works is being erected at Sheffield for the manufacture of steel by the "Carsil" process. It is hoped to give further details in a future issue of this supplement.

Monthly Metallurgical Section

Published in the first issue of "The Chemical Age" each month.

NOTICE.—Communications relating to editorial matter for our *Monthly Metallurgical Section* should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Communications relating to advertisements and other business should be addressed to the Manager. Contributions will be welcomed from correspondents on any points of interest to metallurgists bearing on works practice or current research problems.

Recent Developments in Ammonia Leaching for Zinc Ores

A Process with Possibilities for the Treatment of Complex Ores

RECENT developments in ammonia leaching for zinc ores are dealt with by Mr. H. M. Lawrence, metallurgist in the U.S. Bureau of Mines, in a bulletin, reprinted in part below, published by the School of Mines and Metallurgy of the University of Missouri. The author deals briefly with the history of the development of the process, and reviews present-day operations. His conclusions are that ammonia leaching as a process for the extraction of zinc from complex ores or other zinc-bearing materials has certain possibilities, which are listed.

Progress in the development of ammonia leaching processes for zinc ores has not been as marked as in copper hydrometallurgy. Though basically sound, difficulties have been encountered in the application of the process to the treatment of zinc ores. The equipment and method of treatment has been considered expensive and complicated, requiring close technical supervision in operation. Then, too, the zinc oxide produced was frequently of poor quality, and required further treatment. However, the development of ammonia leaching processes for copper tailings by Calumet-Hecla and Kennecott has demonstrated that large quantities of ammoniacal liquors can be utilised in commercial operations with but a small loss of the volatile reagent, and has also resulted in the development of equipment, much of which is suitable for ammonia processes for the extraction of zinc.

During the past fifty years several investigators have studied the dissolution of zinc compounds by ammoniacal solutions; the majority have favoured the ammonia-carbon dioxide leach, though other solutions containing ammonia have been considered. It is well understood that some zinc compounds, particularly the oxide, are dissolved by ammonium carbonate solutions; after purification of the solutions the zinc may be recovered from the liquors by distillation as a basic zinc carbonate, from which zinc oxide may be produced by calcination. The ammonia and free carbon dioxide that is not combined with the zinc are largely reclaimed by condensing and absorbing the vapours from the distillation. Other methods for the recovery of zinc from the pregnant liquors, including electrolysis, have also been proposed. Operating plants have, however, been few. Two plants, one in Germany and the other in Belgium, using the Schnabel process were operated for several years subsequent to 1878. Mixed lead and zinc oxides produced in the steaming of zinc-lead-silver crusts from the Parkes process were digested with ammonium carbonate solutions, and the zinc recovered from the pregnant liquors by distillation. Though metallurgically successful, the ammonia process at the above plants was abandoned after operating for a number of years, as it could not compete with other methods for the treatment of the liquated zinc-lead-silver crusts. Schnabel's process was, however, the forerunner in ammonia leaching processes, not only for zinc but also for those developed later for copper.

Recent Processes

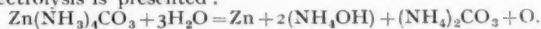
Due to the successful development of ammonia leaching for copper ores, interest has been stimulated in similar processes for zinc ores. Two processes—the Waring and Gordon—recover the zinc by distillation of the ammoniacal zinc carbonate liquors. A small, well-equipped, semi-commercial plant at Webb City, Missouri, which has been used for commercial tests of the Waring process, and there is a plant in intermittent operation at Salida, Colorado, with an estimated capacity of 40 to 75 tons per day in the Gordon process.

In addition to these two processes Campbell studied the electrolysis of ammoniacal zinc carbonate solutions; the process as outlined used ammonium carbonate as the dissolution agent and recovered the zinc by electrodeposition from the purified liquors.

The Waring process is summarised as follows: Complex ores are treated in a special furnace. A shallow charge is carried. In a zone of fusion and reduction, into which fine ore is injected with the primary hot-air blast, volatile metals are vaporised and matte and slag produced. Just above the surface of the charge a hot-air blast from secondary tuyeres oxidises and burns the metallic vapours, sulphur and sulphides to fumes; the latter pass out of the furnace and are collected. The furnace in operation is said to make the following products: matte—containing practically all of the copper, gold, the silver not vaporised, and part of the iron in the charge; slag—clean and liquid, carrying not more than 2.5 per cent. of the zinc in the ore and no lead; fume—pure white, containing zinc, lead, a little silver, cadmium, bismuth, antimony, etc. The subsequent treatment of the fume by ammonium carbonate solutions, averaging about 8 per cent. NH_3 for one hour effects a separation between the zinc and other metals. Of the metal values in the fume the distillation of the purified liquors is said to yield a recovery of at least 95 per cent. of the zinc as basic zinc carbonate, which may be converted into a commercial zinc oxide; the residues should contain over 98 per cent. of the lead and silver, recoverable by further treatment; the elimination or recovery of the cadmium, antimony, bismuth, etc., as may be desired, is said to be equally satisfactory.

An abstract of the Gordon gas-house liquor process follows: Mixed concentrates or sulphide ores are roasted and the calcines treated with gas-house liquor (crude ammonia, largely ammonium carbonate, averaging about 12.5 per cent. NH_3 ; leaching cycle about six hours). After separation from the residues, the liquors are purified and the zinc is recovered by distillation. The residues containing the lead, gold, silver, iron, etc., are suitable for smelting. Expected capacities and results are reported to be: roasting: One furnace, 35 to 40 tons per day of ore containing 40 to 45 per cent. of zinc and lead combined; additional furnace being installed; leaching and distillation: 42,000 gallons of liquor per day or with liquor containing 1 lb. of zinc per gallon, 42,000 lb. of zinc as basic carbonate; extraction (based on trial runs): expected to be 85 to 95 per cent. of zinc with residue containing practically all of lead, iron, precious metals, if any, and gangue.

The Campbell process employs a treatment similar to that of Gordon for extracting the zinc, separating the solutions and residues, and purifying the pregnant liquor. The liquor is then electrolysed, the zinc depositing on the cathode from the complex ion— $\text{Zn}(\text{NH}_3)_4^{++}$ —with regeneration of the ammonia and carbon dioxide. The following reaction for the electrolysis is presented:



The cathode zinc is melted to merchantable metal. In one test Campbell reports that the cell voltage averaged 4.1, the current efficiency about 81 per cent. with an indicated power consumption of 3,950 k.w.h. per ton of zinc. Analysis of the zinc sheets produced showed 0.0183 per cent. iron, 0.0404 per cent. cadmium, and 0.0124 per cent. lead. The Campbell process, though the investigation was on a laboratory scale only,

would seem to have an advantage over other ammonia processes. If metallic zinc, which will require only remelting to be marketable, can be produced directly by electrolysis of the purified solutions, a desirable process would result. It is stated that the high energy consumption could be reduced in practice to about 2,900 k.w.h. per ton of zinc, or an amount comparable with electrolytic practice for sulphate solutions. Details of the plant and process require development, but the process has possibilities that warrant further research.

Extractions

In the processes which have been mentioned above preliminary treatment for the ore or zinc bearing materials is required. Sulphide ores require roasting or fuming. Even if carefully regulated insoluble zinc compounds are formed in roasting. Roasted calcines usually yield less zinc to subsequent treatment with ammoniacal solutions than to an acid leach, and effects of improper roasting are usually more pronounced. Fumes, bag-house products, etc., in some cases prove quite amenable to the process while others are much less tractable. The extractions secured naturally vary greatly, depending upon the previous treatment as well as the original character of the material itself.

Details of Operation

In a commercial plant the treatment of the material—usually minus 35 mesh—for the dissolution of the zinc can be effected in covered steel tanks, in which the ore is kept in suspension in the ammonia solutions by mechanical agitation or by circulation with centrifugal pumps. Solutions may range from 70 to 140 grammes per litre of NH_3 with a CO_2 content of about 70 per cent. of the ammonia; such solutions will usually dissolve zinc at least equivalent to the NH_3 content. Satisfactory separation of the liquors and residues can be made in standard equipment—settling tanks and filters, modified to diminish ammonia losses. Heating the residues may be required to reduce the ammonia loss. Of the original metals, the lead—either as basic carbonate or oxide—most of the iron, precious metals, antimony, bismuth, lime, insoluble, etc., remain with the residues. Cadmium and copper are largely dissolved with the zinc, accompanied by lesser amounts of other metals; these impurities are removed by cementation on scrap zinc. In the agitators some ammonia is fixed as ammonium sulphate due to soluble sulphates formed in roasting and the carbonisation of lead and lime sulphates.

If distillation is used for the recovery of the zinc and reagents from the purified pregnant liquors, a two-stage process may be required, depending upon the amount of ammonia fixed as ammonium sulphate. In the first stage, which may be carried on in multiple effect evaporators or perhaps even in a modified column still, free ammonia and carbon dioxide are volatilised and nearly all the zinc precipitated as basic zinc carbonate. The latter is filtered, a fixed alkali—lime or soda—added to the filtrate to decompose the ammonium sulphate, and a second distillation made in a standard ammonia concentrator, where ammonia is volatilised and zinc precipitated, largely as the hydrate. The still effluent, after filtering out the zinc, runs to waste.

Calcination at comparatively low temperatures converts the precipitates of basic zinc carbonate and zinc hydrate into zinc oxide. The quality of the zinc oxide produced will depend somewhat upon the original ore treated, but more largely upon the amount of iron introduced after purification of the pregnant liquors. The calcined product may require refining to produce merchantable zinc oxide. The consumption of reagents cannot be estimated with any exactness. The character and grade of the zinc-bearing material, as well as the treatment employed, would markedly affect the reagent losses. Waste effluent from the distillation ought not to contain more ammonia than in copper practice, or from 0.05 to 0.3 grammes per litre NH_3 with only traces of zinc. Total ammonia losses might be low—up to 5 lb. per ton of material treated—but on high-grade fumes the loss might be 20 lb. per ton or even somewhat more. Consumption of carbon dioxide would be high, though some might be reclaimed by absorbing the gases evolved from the precipitate during calcination. Steam for distillation would vary from 3 lb. to 6 lb. per gallon of liquor evaporated; the lower amount might be sufficient, particularly if only a small amount of ammonium sulphate were present, permitting a single stage distillation to be used.

The consumption of reagents in pounds per pound of zinc as basic zinc carbonate ought not to exceed the following:

NH_3 —0.025 lb.
 CO_2 —0.25 lb.
Steam—5 lb. to 9 lb.

Summary

Ammonia leaching, as a process for the extraction of zinc from complex ores or other zinc bearing materials, has certain possibilities that may be briefly pointed out.

(1) If calcines from the roasting of sulphide ores are treated, zinc extractions are likely, in general, to be somewhat lower with an ammonia than with a sulphuric acid leach. However, fewer impurities would be dissolved by the ammonium carbonate solutions and their subsequent removal should be more readily effected.

(2) If sulphide ores are fumed and an amenable fume product secured, treatment with ammonium carbonate solutions should yield high zinc extractions in a liquor that can be readily purified.

(3) Satisfactory recoveries of desired metal values from (1) or (2) should be made by smelting or other methods.

(4) If distillation of the purified pregnant liquors is practised, the precipitation of the zinc as basic carbonate or hydrate and the reclamation of the reagents should be effected with an economical steam consumption and with but little loss of ammonia. Oxide produced by calcining the precipitated zinc carbonate and hydrate would probably require refining to obtain a marketable grade of zinc oxide.

(5) The possibility of obtaining zinc as metal by electro-deposition from purified zinc ammonium carbonate solutions warrants investigation.

(6) For successful operation a well-designed plant, accessible for observation and repairs, is essential. Corrosion of equipment should be less than with ammonia processes for copper ores.

London Tin Syndicate Annual General Meeting

THE second annual meeting of the London Tin Syndicate, Ltd., was held in London on November 18, Lord Askwith (chairman of the company) presiding. In moving the adoption of the report and accounts the chairman said that the total on liability side of the balance sheet, including the capital, £250,000, the reserve fund, £197,196, creditors, £11,380, and the balance at credit of profit and loss, amounting to £136,474, was £595,052. The assets were investments at cost, £405,293, properties and ventures, £44,252, outstandings, £5,300, and cash in varying forms, £140,000. The board recommended the payment of a final dividend of 40 per cent. less tax, making 50 per cent. for the year, the transfer of £12,800 to reserve, and the carrying forward of £29,671. In concluding a summary of the syndicate's activities, the chairman said that he ought to refer briefly to rumours that they had tried to corner spot tin, and later that a violent reaction in the tin market had been caused because they had not cornered tin. The title of this syndicate might possibly have created a misapprehension, as the syndicate did not engage in the sale or purchase of tin ore, tin oxide, or metallic tin.

On the question of the price of tin they might well feel concerned as to future sources of supply, but he was convinced that shareholders need not pass any sleepless nights in reflecting on the possible value of their shares, or over factitious depression in the price of the metal. The real menace lay in the opposite direction. The prime factor in the situation was the threatened shortage, which it was their business to endeavour to postpone by the exploitation of new sources of supply to the benefit not only of themselves, but of the wide circle of industries which depended, in part at least, on the continuance of constant and regular supplies of metallic tin.

Dealing with properties and investments, the chairman said no doubt was entertained as to the success or long life of Parkanchy, which was on the eve of production, and the future of Pohigey was no less assured. The most important of all the syndicate's acquisitions was the Penpoll smelter, for which they had been fortunate in securing the services of Mr. Allen, who had been closely identified with the designing and construction of the Straits Trading Co.'s new smelter in Penang, the largest and most up-to-date in the world.

The report and accounts were adopted.

A New Theory of Chromium Plating

Mr. Ollard's Communication to the Electroplaters' and Depositors' Technical Society

At a meeting of the Electroplaters' and Depositors' Technical Society, Mr. E. A. Ollard read a paper on a new theory of the electrodeposition of chromium. A special invitation had been extended to the members of the Faraday Society and the London Section of the Institute of Metals, to which there was a gratifying response. Mr. S. Field, the president, occupied the chair.

Mr. Ollard, in the course of his remarks, said that so far, three theories had been put forward to account for the working of the chromium bath. The first of these seemed to be chiefly held by the American workers. It was to the effect that the deposition of the chromium took place from the small percentage of chromium sulphate (or other salt) in the bath, and that the chromic acid functioned as a reservoir from which the chromium could be drawn. They appeared to consider that the chromium sulphate electrolysed to give chromium and a sulphate ion that reacted with the chromic acid, regenerating chromic sulphate. As it stood this theory was open to objections, the chief being that there was no evidence to show that a sulphate ion would react with chromic acid, or, if it did, that it would form chromic sulphate, while the theory did not show why better results should not be expected from chromic salts alone.

Dr. Liebreich had studied the current-voltage curves at a platinum cathode in chromic acid solutions, and had come to the conclusion that the deposition of chromium took place in steps from the chromic acid itself, the hexavalent chromium being reduced by the current first to the trivalent form, then to the divalent, and finally to the metal. His theory, however, did not explain why pure chromic acid should not also give deposits of chromium, or the function of the additions of other acids. He had, however, produced a great deal of evidence to show that divalent chromium compounds were formed prior to the deposition of the metal. Dr. Muller had endeavoured to explain the action of the sulphuric acid by a complicated theory of colloidal diaphragms. He suggested that the chromic acid was reduced at the cathode by the nascent hydrogen, but that the reaction was stopped immediately by the formation of a semi-permeable membrane of chromic chromate produced from the reduction products, allowing only hydrogen to pass through it. He further suggested that the addition of another acid modified the diaphragm and allowed the reaction to proceed.

Constitution of the Depositing Solution

From conductivity tests, potentiometric measurements, migration tests, and chemical analysis which had been made it was considered that the solution must consist essentially of the following constituents, in order that deposits of chromium might be obtained from it:—

1. Bichromic acid Usually in fairly large quantities, but may be reduced almost to zero.
2. Bichromate of chromium $\text{Cr}_2(\text{Cr}_2\text{O}_7)_3$ From nearly zero to a very large percentage varying inversely as the amount of bichromic acid.
3. A substance that will give another anion, as sulphuric acid or a sulphate A small quantity only, which has to be very carefully controlled and varies with the type of bath used, and the material itself.
4. A complex colloidal compound of chromium of type $\text{Cr}_2\text{O}_3 \cdot x \text{CrO}_3$, where x is low Colloids of this description are found but do not appear to be present in large quantities, and there is no evidence that they are beneficial.

The first two constituents were obtained by dissolving chromic trioxide in water and reducing to the desired degree by a convenient method. The third constituent was carefully added in the required amounts, although in some cases part of this might be present as an impurity in the chromic trioxide and must be allowed for. The existence of the fourth constituent was doubtful, but if present it might be either formed during the reduction of the chromium trioxide or by subse-

quent electrolysis. It was by no means unlikely that the last suggestion was correct, and it was found that colloids could be experimentally produced in this way.

It was not considered possible that in a bath of this nature any divalent material could exist in the bulk of the solution, while at rest. The composition of the solution must therefore be considered as being bichromic acid and chromic bichromate, together with a small quantity of chromic sulphate (or other salt). The concentration of the trivalent ions would be governed by this latter constituent, since the chromic bichromate as shown above ionised only slightly, and would therefore serve as a buffer substance.

Mr. Ollard's View

From a careful consideration of all the data available the mechanism of the reaction was considered to be as follows:— In the body of the solution, trivalent chromium compounds (usually the sulphate) ionised to give a trivalent ion. When current was passed the bichromic acid functioned as a conducting material, and the chromic ion was carried to the cathode. The bichromic acid would be electrolysed, forming oxygen and hydrogen, while the chromic salt would give at the cathode a chromic ion and at the anode the ion of the corresponding radical, which latter would react with the chromic bichromate reforming the salt and bichromic acid. The chromic ion would be reduced at the cathode, forming first a chromous ion and then the metal. Some of the chromous ions formed might, however, escape from the cathode layer, reacting with the bichromic acid to form further quantities of the chromic bichromate. The equations for these actions would be given later. Thus the bichromic acid formed the conducting material and regulated the acidity, the chromic bichromate formed a buffer substance and reduced acidity, and the chromic salt provided the supply of chromic ions from which the deposit of the metal took place. Some colloidal matter might be formed on the cathode and might affect the structure of the deposit, but it did not appear that there was any great quantity of such material in the body of the solution.

The Discussion

An interesting discussion followed, in which various objections to the theory were put forward. The president, after congratulating Mr. Ollard on his paper, pointed out that the experimental work had been carried out with a solution containing 600 gms. chromic acid per litre, whereas that employed in practice contained 250 gms. Presumably, the time required to produce the "complexes" and to reduce the conductance would be thus shortened. Also, why could we not use more than 3 gms. chromic sulphate per litre of solution?

Mr. Wernick (secretary) compared the theory advanced with those put forward by Sargent, Liebreich and Muller, and said the great value of Muller's theory lay in the conception of a diaphragm or film at the cathode. This was tangibly formed and gave a great deal of trouble in practice. How was this accounted for in Mr. Ollard's theory?

Mr. D. J. Macnaughton referred to the fact that the chromium dichromate, which Mr. Ollard considered was essential in the bath, had definitely been stated to be not only unnecessary, but positively deleterious by Haring, of the American Bureau of Standards. He thought that Muller's theory had not been properly considered. Mr. G. E. Gardam said the theory did not explain why an excess of chromic sulphate interfered with the working of the bath; while, again, a small amount of chromic acid present should be capable of resulting in a deposit. Mr. L. Wright pointed out that the hydrogen content of the bath was an important factor. With regard to colloids, it was quite possible to obtain a deposit without using a colloid; while the latter definitely went to the anode by cataphoresis.

Mr. Ollard then replied to the discussion at length, and on the motion of Mr. D. Macdonald, seconded by Mr. W. James, was accorded a hearty vote of thanks.

Copies of the paper are obtainable from the acting hon. secretary of the Society, Mr. S. Wernick, B.Sc., Northampton Polytechnic Institute, Clerkenwell, London, E.C.1, at 2s. per copy.

Metallurgical Topics: Monthly Notes and Comments

From Our Own Correspondents

Rival (?) Institutes

SOME amusement has been caused amongst officials and members of the Iron and Steel Institute and the Institute of Metals at a recent suggestion that these two Institutes overlap, and that many of their functions could be more adequately discharged by the Institute of British Foundrymen. Any such proposition reveals an almost pathetic degree of ignorance of the state of metallurgy, to say nothing of the status of the three Institutes, each of which has its own distinct and equally indispensable spheres. The first two combine, happily enough, the fields of pure and applied science in two very highly specialised branches of industry; the third carries out, so far as it is able to do so, the practical applications of both in a still more specialised field, the craft of the foundry. In so far as there are both ferrous and non-ferrous foundries, both the Iron and Steel Institute and the Institute of Metals foster investigations of the greatest value to the practical foundryman, but they do very much more than this, and indeed the great bulk of the papers read at their meetings have nothing in common either with one another or with foundrymen. On the other hand, those read before the branches of the Institute of British Foundrymen deal, or should deal, with severely practical considerations as to the manufacture of castings; and must take on trust the data provided by the other Institutes, and apply them to the work in hand.

Specific Functions of the Leading Institutes

THAT, on the other hand, the cause of science, in foundry and workshop, is greatly served, in the long run, by the occasional holding of joint meetings between two or more societies for the discussion of various aspects of some one subject, is plainly shown by the success that has attended the Faraday Society's attempts in this direction. At such meetings the papers usually deal with profound and basic physico-chemical considerations which only experts can understand, let alone discuss. The type of paper read at a Faraday Society meeting would be utter Greek to the average foundryman. The highest practice and the highest theory seldom meet on common ground, for the simple reason that the conditions in which theory emerges differ entirely from those with which practice has to deal. The light thrown on scientific subjects by abstruse physico-chemical considerations has to be attenuated, so to speak, before it is applied to such homely uses as moulding, venting, and gating. The Institute of Metals and the Iron and Steel Institute constitute, so to speak, the filters by means of which high abstractions reach industry in serviceable form.

Symposium on Cohesion

THE Faraday Society has been holding, as recently as last week, one of the discussions to which reference has been made. It dealt with the very fundamental subject of cohesion. Professor Desch, in his introductory address, summed up, under nine points, the phenomena depending on the nature of cohesion which are of interest to the engineer and metallurgist. The mere statement of these points shows how vastly complicated, and how little understood, the subject, nature, and effects of cohesion are. Professor Desch wisely refrained from attempting any definition of cohesion, or from putting forward any theory to account for the phenomenon. Other contributors deal with various aspects of the subject, one of the most interesting and suggestive being the paper by Dr. Adam on "Cohesion in Surface Films." As he said, some progress has been made in mapping the broad outlines of the attractive forces round molecules, and the repulsive forces: enough to show that many of the structural formulæ of organic chemistry do, in reality, represent things which have some correspondence with actualities. He, too, refrained from any dogmatism as to the nature and operations of "cohesive forces." Of all the theoretical papers read at the meeting, those by Professor Polanyi and by Professor Richards stood out as the clearest and most suggestive. Even they propounded no general conclusion. Of the practical papers, those by Professors Haigh and Gough on "Hysteresis," and "Fatigue" in relation to cohesion, respectively, will appeal most to metallurgists.

Tarnish-Resisting Silver Alloys

AMONGST the many generalisations of science which, on account of exceptions thereto, have to be liberally discounted, is that which lays it down that a pure metal is less corrodible than a metal with an impurity, for any alloy may be regarded as a main metal "contaminated" by the presence of another, and some alloys, at least, are far less easily corroded than some of the metals of which they consist. Stainless steel is a beautiful and useful metal; more so in engineering applications and for "fittings" perhaps, than in the more homely aspects of table cutlery, seeing that a stainless steel knife that really keeps its edge—or has one to keep—is hard to come by. Stainless silver would be a boon, indeed, particularly in these foggy December days, when an unsightly film makes the housewife's task of keeping the silver clean very difficult. It is to be regretted, therefore, that the admirable research carried out at the Department of Commerce, Bureau of Standards, Washington, by L. Jordan, L. H. Grenell, and H. K. Herschman, does not bring us very much nearer to the realisation of a stainless silver alloy. The investigations carried out were very extensive and included the preparation and testing of silver alloyed with aluminium, cadmium, magnesium, zinc, silicon, tin, bismuth, antimony, tellurium, manganese, nickel, molybdenum, titanium, chromium, germanium, and beryllium, as well as ternary alloys of several of these metals.

Trade Attitude to "Stainless Silver"

It is curious to note that "the trade" was not enthusiastic in regard to the search for a stainless alloy: curious, but not altogether difficult to understand. The "tarnish" coloration of recessed portions of ornamental work is often regarded as enhancing the artistic appearance of silver articles. Again, the public expect silver to be mainly silver, a standard alloy of the kind to which they are accustomed, and not a silver debased, so to speak, with a less noble metal. In the result it was found that the cadmium, or zinc alloys were, from the non-tarnishing point of view, the most promising, but they had the lowest tensile strength of all the binary alloys. Antimony and tin gave better results, particularly when zinc likewise was present. The authors of the research conclude that while an absolutely non-tarnishing silver alloy of suitable properties in other respects would have commercial possibilities, the development of such an alloy is unlikely, as no really non-tarnishing composition was found, and there is little likelihood of this being accomplished.

Sir Chunder Bose's "Collected Papers."

THE "Collected Physical Papers" of Sir J. Chunder Bose (Longmans: 10s. net) were originally communicated to the Royal Society, although some of them appeared in *The Electrician* a good many years ago. Sir Chunder Bose was in advance of his time then, and more than abreast of it now, for his collected papers contain much to fascinate and inspire metallurgists. He, too, has much to say about cohesion, using the term in the sense of the coalescence or coherence of particles in "coherers" under the action of short Hertzian waves, and under varying conditions affecting resistivity. Some of the researches are admirable in their conception and in the way in which they have been carried out, which recall the "grand manner" of Faraday. Thus, in the discussion of the molecular changes produced in matter by the action of electric waves he assumed certain hypotheses which, with their necessary deductions, are plainly stated. He then carried out the experiments germane to the principles sought to be established. The conclusions are then logically and legitimately drawn. This is the right scientific method and spirit. In the result many of his observations on the conductivity of metals under the action of electric radiation will be of value to electro-metallurgists and students of electro-deposition.

Analogies Between Metals and Man

His analogies between the response of metals and other inorganic bodies and living tissues to electrical stimulation are very suggestive. The same phenomena repeat themselves

in varying degree: fatigue, strain, hysteresis. Indeed, the section on molecular strain, capable of detection by variation in conductivity, has a distinct lesson for metallurgists. Sir Chunder Bose constructed an artificial retina, composed of galena. The sensitive receiver was placed inside a hollow spherical case with a circular opening in front, provided with a glass lens! The retina, as indicated by a sensitive galvanometer measuring the variational conductivity, was sensitive to variously coloured light, etc. Such experiments and results offer fruitful fields for investigation. Moreover, the paper on the electromotive wave accompanying mechanical disturbance in metals in contact with electrolytes has more than a passing interest for those interested in electro-deposition of metals. The effects of "excitants" "depressants," and "poisons" on the solutions, both under normal and electrical radiation, appear to affect metals hardly less than they do man and the animals and plants, although in different degrees. Recovery and immunisation have their scope and functions in metals as in "organised matter."

Thermal Expansion of Beryllium and its Alloys

DATA on the linear thermal expansion of beryllium have been reported by the United States Bureau of Standards in *Technical News Bulletin*, No. 118. The investigation on the thermal expansion of this metal and aluminium-beryllium alloys (4 to 33 per cent. beryllium) was undertaken because of the interest shown in aluminium-beryllium alloys in connection with automotive engine pistons, there being no information available on this subject. Expansion determinations were made over various temperature ranges between -120° and $+700^{\circ}$ C. on a sample of beryllium (98.9 per cent.), and between room temperature and 500° C. on the aluminium-beryllium alloys. Beryllium, a metal about 30 per cent. lighter than aluminium, has received until recently very little attention. This interesting metal expands considerably less than aluminium and approximately the same as iron or ordinary steel. Aluminium-beryllium alloys also expand less than aluminium. For example, an aluminium-beryllium alloy containing 30 per cent. beryllium has coefficients of expansion approximately 20 per cent. less than those of aluminium. The relations between the coefficients of expansion and the chemical composition were compared with the equilibrium diagram obtained by Oosterheld, and were found to be in agreement with the theory of this type of diagram. A scientific paper which gives detailed data on beryllium and aluminium-beryllium alloys is now in the press.

Cast Iron Research Association Report

THE sixth annual report of the British Cast Iron Research Association, for the year ending June 30, 1927, has been issued. The balance sheet indicates that in the period under review expenditure exceeded income by £1,071. Except, however, for a sum of £68, this is wholly in respect of expenditure on new premises, which has been charged to revenue. It was the council's intention when the scheme for centralising offices and laboratories matured, to approach members for contributions to meet the expenditure contemplated, but the general disorganisation of industry owing to the coal dispute rendered this course inadvisable. The council has felt that the Association cannot regard its equipment as complete until it has a small foundry, and it was necessary to forgo this part of the original scheme entirely. It is hoped to make arrangements shortly to rent a small foundry near the headquarters offices, adjacent to the works of a member. The subscribing membership of the Association in all classes is 290, of which the number of ordinary and trade members is 226.

The difficulties encountered by members in meeting the situation created by the coal strike, which necessitated working with unfamiliar imported raw materials in the form of pig iron and fuel, threw extra work on the staff. The general pre-occupation of the business world hampered propaganda work, progress in which had been confidently anticipated in view of the experience of the two previous years, and the general difficulties were responsible for several withdrawals from membership, particularly among small foundries. This was particularly unfortunate in view of the hopes entertained of a fuller response from the industry following the highly satisfactory report made by the Committee of the Department of Scientific and Industrial Research at the end of the first five years' working of the Association.

The New Premises

THE last report recorded the transfer of the Association's registered office and laboratories to 24, St. Paul's Square, Birmingham, although in actual fact the change took place in the financial year now under review. The extra space afforded for the growing work of the Association, and the convenience of having offices and laboratories under one roof, has resulted not only in greater ease of supervision, but in considerable working economy. The whole of the anticipated economies, however, will only be realised in the current financial year, which will be the first complete year under the new conditions. During the year under review double rental charges had to be met for the overlapping period when the alterations to the new premises were being carried out, while costs of power, fuel, and light were greatly augmented during the coal dispute.

Research and experimental work in progress during the year included investigations on moulding sands; heat-resisting cast iron; the graphitisation of iron; production and treatment of malleable cast iron; cupola practice; equilibria of iron carbon alloys; influents of elements on chill; irons for light castings; nickel in cast iron; and corrosion-resisting cast iron.

British Metals Corporation Developments

It is stated that the British Metals Corporation has acquired, in Nova Scotia, from the American Cyanamide Co., the Smithfield silver-lead deposits, 20 miles from Truro, and the Stirling zinc properties near Richmond County, Cape Breton Island. The British Metals Corporation are now taking in a Carels-Ingersoll-Rand type direct-connected Diesel oil engine-driven compressor of 608 cubic feet per minute capacity. This machine, the first of its kind to be placed in operation at a Canadian mine, combines the large fuel economy of the Diesel oil engine with the mechanical efficiency of straight line construction and two-stage compression. The ore at the Stirling mine occurs in zones with a width of as large as 90 feet, and runs from 10 per cent. to 30 per cent. zinc with small additional values in gold, silver, and copper.

Cleveland Iron Masters Establish Selling Agency

A CENTRAL agency for handling all business in the Scottish market and to abolish all dealings through merchants for this market is being established by the Cleveland Iron Masters. It is intended to establish direct contact with the consumers, in the hope that this will assist in reviving the pre-war volume of business between Tees-side and Scotland. The selling agency has been placed in the hands of J. and A. McMorland, Glasgow, and all business in Cleveland pig iron is now to be done through this firm, as representing the producers on Tees-side. It is stated that three firms—Pease and Partners, Dorman, Long and Co., and Bolckow Vaughan and Co.—are interested in the scheme, and it is possible that a fourth firm on Tyne-side will come in. The new scheme will result in one agent selling for the whole of the producers, and it is hoped to reduce expenses. Orders will be distributed among firms forming the selling association. Those in the best position to supply the iron would do so, and in this way they hope to give their customers a better service. Middlesbrough firms take the view that the scheme will not cause the merchant any harm immediately, because the Tees-side has been selling little iron to Scotland for a considerable time, and if the merchants are excluded from Scotland, as far as Cleveland iron is concerned, they may have to develop trade between Northamptonshire iron and Lincolnshire iron in competition with Cleveland iron. Continental competition has been very keen in the Scottish business for a long time, and continental iron has been underselling the Cleveland product by 7s. a ton. Before the war, however, the Scottish market was worth about one thousand tons of Cleveland iron a day to Middlesbrough, but to-day a weekly shipment to Scotland of two thousand tons is considered good.

The central selling agency is certain to be given a fair trial by the iron-masters, and it will be watched with interest by consumers, merchants, and iron-masters in other parts of the country. If it brings more business to the industry on Tees-side there will be considerable satisfaction, but merchants contend that under the existing conditions there can be no great increase in the volume of business, and if a reduction in price is contemplated the merchants can obtain as much business as the newly-formed central agency.

Trade, Commerce, Finance: The Month in Review

From Our Northern Correspondent

The iron and steel trade for the month of November offers no interesting feature, certainly no encouraging one. Conditions are no better than they were in the previous month, and despite the reports which one sees in the Press from time to time there is as yet no sign of any recovery from the depression experienced during the past months; indeed, no change is now looked for this side of Christmas. What the New Year will bring one cannot say, although the prospects are not hopeful.

Lack of Confidence

The market lacks confidence. The flow of orders and the trend of business are not such as to inspire confidence, and it is as much as most works can do to keep the mills running from week to week. In every district one hears of short time being worked in various departments, and nowhere is there a sufficient weight of orders to ensure steady operation for any length of time ahead. There is the index of the whole position. So long as this day-to-day operation is all that can be relied upon, so long will the market be weak, prices droop, and business generally be dull.

The rebate scheme has not improved matters. It cannot be said that there has been any increase of orders to the steel works as a result of the scheme, and it has certainly had little or no effect on the import of continental steel. Three months have now elapsed since the scheme was put into operation, and the experience of that three months does not justify the basing of any extravagant hopes on its achievements. It will probably resolve itself ultimately into nothing more than a small reduction in price on the controlled materials, effected in a manner which throws a good deal of extra work on the steel makers without bringing in any adequate return. Judging by the number of claims sent in there is a large proportion of the consumers who do not consider the rebate sufficient to warrant their sacrificing the right to place orders where they will, and, as stated on previous occasions, those who do claim would have confined themselves to British steel in any case.

Pig Iron Trade

There is really no activity in any section of the market. Pig iron, finished iron and steel are all dull. A month or two ago there seemed to be prospects of some stability and improvement in the pig iron trade, and it was possible to make a small advance in price, about 1s. per ton. The makers have with difficulty managed to maintain that advance, but it is none too secure and business is now very much on the quiet side. There are few forward contracts being placed and purchases are limited to the requirements for the few remaining weeks of the year. Specifications are coming in fairly well against contracts already placed, and this leads the makers to think that there may be renewed buying in the New Year. The demand for basic pig iron is very flat, as might be expected from the diminishing output of steel.

Finished Iron and Steel

The finished iron makers continue to experience adverse conditions. The demand for iron is very irregular. Prices are already as low as makers dare cut them, yet outputs are not sufficient to keep the mills anything like normally busy. What with the low prices, the high costs due to part-time operation, and the short demand for iron, the industry is in a most unsatisfactory condition. It is impossible to meet the competition of continental iron, the difference in the price being well over £3 per ton. The marked bar section is only moderately busy.

In finished steel also, orders are placed only for present requirements, and these are so limited that there is the keenest competition for any orders that are about. The prices of the controlled materials are, of course, fixed, and while these are being officially adhered to, instances are reported of concessions and allowances being made in order to get a preference of the work that is placed. It is to be hoped that these reports are not correct, or if they are, which is more likely the truth, that the evasions will cease, as the

Association is only on sure ground so long as the members abide faithfully by its rules, and a break-up would mean another spell of useless price-cutting. This is shown by the keen competition there is among the various makers for orders outside the Association.

Boiler plates, billets, and small bars have all declined considerably in price, and there is no saying what figure would be accepted if a good specification were offered. The unsatisfactory feature is that the costs of manufacture do not warrant any reductions or price cutting. Coal and coke are cheaper now than at any time since the War, and it is no use expecting any further substantial relief. If the present slackness in the coal trade continues there may be a slight concession in price due to the urgent necessity to secure orders, but it can be only slight, and the first sign of a revival in the coal trade would mean a stiffening of the price. The same applies to coke. Other items of cost are down at as low a level as can be expected. Scrap is in poor demand, and is being offered at a price which it has not touched for some years, but even 52s. 6d. does not tempt buyers, unless they are prepared to put the material into stock.

The Wages Problem

Wages, for the majority of the men, are already so low that it would be impossible to reduce them further without inflicting serious hardship on the men, many of whom are finding it difficult to keep body and soul together. Indeed, the steel industry must sooner or later be prepared to meet a definite demand for the amelioration of these conditions, and this will not be long delayed if the present unsatisfactory conditions continue. Internal economies have been exploited to the full, and the steel makers are at a loss to know where further savings can be effected.

In this connection, some amount of attention is being paid to the possibilities of amalgamation as a means of effecting economies in administration and distribution. In those cases where it has already been tried it has not been a conspicuous success, although they have hardly been of the character to ensure success. To provide reliable guidance it should be carried out on the same lines as in Germany, or in a manner similar to that adopted by the Imperial Chemical Industries, Ltd. The difficulty is to persuade the individual steel makers to sink their individuality where by so doing the trade as a whole can be benefited. An interesting experiment is likely to be made shortly in this direction, in connection with the export trade, the suggestion being to form an organisation which shall control the bulk export sales and allocate the orders to the works. If the suggestion is put into practice its results will be watched with interest, and the experience gained may be very useful in assisting to decide how far similar control can be exercised on the general production of iron and steel.

The output of pig iron in October amounted to 596,300 tons, compared with 591,500 tons in September and 596,100 tons in August. The number of furnaces in blast was two more than at the end of September but three less than at the end of August. The output of steel for October was 699,000 tons, compared with 777,000 tons in September and 643,100 tons in August.

Independent U.S. Steel Makers to Co-operate

The announcement last week that Kuhn, Loeb and Co., of New York, were offering 75 million dollars in bonds for the Youngstown Sheet and Tube Corporation is regarded as a move by the independent steel makers of the United States to co-operate in competition with the powerful United States Steel Corporation.

The Youngstown Corporation is the third largest steel corporation in the United States. Further colour is lent to the idea by announcement of the merging of the Republic Iron and Steel Co. with the Trumbull Steel Corporation, involving combined assets equal to £40,000,000. The merger will be subject for ratification by the stock holders of the two companies.

Some Inventions of the Month

By Our Patents Correspondent

Abstracts of other Patents of metallurgical interest will be found in our Patent Literature published weekly in THE CHEMICAL AGE.

Alloys

T. D. KELLY, of London, finds that alloys of nickel, molybdenum, and chromium can be prepared which are malleable when cast, as compared with the usual alloys of molybdenum and chromium, which are very hard. Such alloys contain from 33 to 90 parts of nickel, from 5 to 33 parts of molybdenum, and from 5 to 33 parts of chromium, the ingredients being melted under a flux of calcium or magnesium chloride containing carbon. See Patent No. 277,170, having the date September 10, 1926.

According to H. Yoshikawa, of Tokio, Japan, the physical properties of lead, such as tensile strength, ductility, etc., can be improved without impairing its resistance to chemical action by alloying it with not more than 10 per cent. of a metal immiscible with lead, such as copper, nickel, cobalt, manganese, chromium, or aluminium, and not more than 4 per cent. of bismuth, no other metal being present. Thus lead alloyed with 0.1-1 per cent. of copper and 0.25 per cent. of bismuth has nearly twice the tensile strength of lead with almost the same elongation. See Patent No. 277,199, having the date November 22, 1926.

Magnesium alloys suitable for the pistons of internal combustion engines are prepared by alloying with the magnesium up to 15 per cent. of aluminium and 1-6 per cent. of silicon. See Patent Application No. 275,985, by I.G. Farbenindustrie Akt.-Ges., Germany, having the International Convention date August 13, 1926.

Copper and Zinc

THE copper present in the liquors resulting from the lixiviation of chlorinated roasted pyrites is removed as insoluble cuprous salts produced by treatment with reducing agents such as sulphurous acid, thiosulphate sulphides, or metals. The remaining copper is then precipitated by means of iron. If the lixiviation liquors consist of a portion rich in zinc but poor in copper and a portion rich in copper but poor in zinc, only the latter portion is treated with the reducing agent, after neutralisation with zinc oxide waste products to precipitate most of the copper as cuprous chloride. The remaining solution, together with the other solution poor in copper, is treated with iron to remove copper, and finally concentrated and further treated for recovery of zinc and cobalt. See Patent Application No. 276,008, by H. Grothe and Metallhütte Magdeburg Ges., Magdeburg, Germany, having the International Convention date August 11, 1926.

According to a Patent Application by I.G. Farbenindustrie Akt.-Ges., Frankfurt-on-Main, Germany, copper hydroxide is precipitated from metallurgical liquors by means of zinc hydroxide in two or more stages. The zinc hydroxide is first added in quantity insufficient to precipitate all the copper, whereby a precipitate free from zinc is obtained. The zinc-containing precipitates obtained in subsequent stages are used as precipitants in the preceding stages. See Patent Application No. 276,017, having the International Convention date August 14, 1926.

Molten copper and copper alloys are purified by adding to them an alkaline earth metal such as magnesium; the latter is preferably added in the form of an alloy with aluminium containing about 10-15 per cent. of the latter. See Patent Application 276,341, having the International Convention date August 18, 1926.

When zinc is extracted from ores by means of sulphuric acid, and the zinc isolated by electrolysis, it is necessary to free the zinc sulphate solution from metallic impurities prior to electrolysis, otherwise the deposition process may be inefficient and the zinc impure. According to a patent by The Rhodesia Broken Hill Co., Ltd., London, the purification can advantageously be effected by treating solutions with a derivative of dithiocarbonic acid of the type MS.CS.OR, M being a metal or equivalent group and R an organic radicle, the compounds (xanthates) in which R is an alkyl group, such as zinc xanthate, being particularly convenient. Zinc xanthate is substantially insoluble in water, but sufficiently

soluble in zinc sulphate solutions to effect precipitation of metals such as copper, cadmium, cobalt, and nickel. The presence of some copper materially assists in the precipitation of the other metals, and copper compounds may be added if such are not present. See Patent No. 278,851, having the date September 1, 1926.

Aluminium

A. KIRCHOFF, of Meerane, Saxony, Germany, describes a process of purifying aluminium which consists in using powdered animal shells, such as those of molluscs; the waste obtained in the manufacture of mother-of-pearl buttons, etc., is particularly suitable. Impurities such as alumina and foreign metals are stated to be removed. See Patent No. 278,164, having the date September 16, 1926.

A known process for obtaining very pure aluminium consists in an electrolytic treatment in which three layers are used. The upper layer (the cathode) consists of the refined metal, the central layer is the electrolyte, and the lower layer (the anode) the preliminarily refined metal, to which, however, has been added a metal such as copper, which will render the metal sufficiently dense to remain at the bottom. In a similar process of the Deutsche Versuchsanstalt für Luftfahrt, Berlin-Adlershof, Germany, the anode layer is alloyed with a precious metal of high specific gravity, preferably one which is not taken up by aluminium in solid solution. Such metals are gold, platinum, or silver. They remain unaltered in the anode layer and do not separate in the cathode layer as does copper. See Patent No. 276,911, having the International Convention date December 2, 1926.

In Patent Applications by H. Schorn, Lausitz, Germany, are described aluminium alloys containing 0.05-1 per cent. of titanium, which can be obtained by electrolysis of alumina containing titanium compounds. Such an alloy containing in addition 1-6 per cent. of magnesium is stated to be resistant to the action of sea water. See Patent Applications 277,701 and 277,702, having the International Convention date September 18, 1926.

The Metallbank und Metallurgische Gesellschaft, Frankfurt-on-Main, Germany, find that alumina which has been heated to temperatures above 1,300° C., rapidly cooled, and crushed, dissolves more easily in a cryolite flux for the production of baths for the electrolytic preparation of aluminium. See Patent Application 277,640, having the International Convention date September 18, 1926.

Iron and Steel

A PATENT by J. Y. Johnson, London, from I.G. Farbenindustrie Akt.-Ges., Frankfurt-on-Main, Germany, describes a process for reducing iron ores in which the reducing agent consists of reducing gases made by the combustion of powdered fuel with an amount of oxygen, or air enriched in oxygen, insufficient for complete combustion. The iron ore may be treated in counter-current in a shaft or rotary furnace at 800-1,300° C., and the iron finally melted in any suitable manner, but preferably in a shallow hearth by means of the hot reducing gases from the producer prior to their use in the reduction process. The iron may also be melted in the generator for the reducing gases. A malleable iron is directly obtained, and low-grade fuels such as lignite, lignite coke dust, dried peat, or peat coke, may be used. The residual gases from the reduction may be in part returned to the gas producer and may also be used, by treatment with steam, for the production of gases for use in the synthesis of ammonia or methanol, or for other hydrogenation processes. See Patent No. 278,167, having the date March 29, 1926.

The frothing which occurs when cyanide-containing baths are used in the hardening of iron and steel articles at high temperatures (above 860° C.) is prevented by an addition of a finely divided carbonaceous material or of a carbon-containing material which will yield carbon at the temperature of the bath, such as a higher hydrocarbon. Thus a bath for use at 950° C. may consist of sodium cyanide and sodium cyanamide with an addition of 2.5-3 per cent. of powdered wood charcoal. See Patent Application 277,030, by the Deutsche Gold und Silber Scheideanstalt vorm. Roessler, Frankfurt-on-Main, Germany, having the International Convention date September 6, 1926.

Current Articles Worth Noting

We give below a brief index to current articles in the technical Press dealing with metallurgical subjects.

ALLOYS.—A study of the annealing effects of certain copper-nickel-aluminium-manganese alloys. L. J. Wood. *J. Phys. Chem.*, November, pp. 1693-1703. Alloys of the Cu-Ni-Al system having a Ni-Cu ratio of approximately 2 and an aluminium content of 2 to 6 per cent. have been shown to form essentially an alpha solid solution when sand-cast and quenched from just below red heat. One per cent. of manganese added to the alloys tends to cause a separation of a second constituent.

Tensile tests on alloy crystals. IV. A copper alloy containing 5 per cent. aluminium. C. F. Elam. *Proc. Roy. Soc. A.*, November, pp. 694-702.

Investigations on the ternary system lead-zinc-bismuth. H. Fincke. *Die Metallbörse*, November 19, pp. 2851-2852 (in German).

The protection of duralumin by electro-plating with various metals. M. Haas and O. Pöttken. *Z. Metallkunde*, November, pp. 448-451 (in German).

Alloys containing a high percentage of magnesium. W. Schmidt. *Z. Metallkunde*, November, pp. 452-458 (in German). An account of the properties of magnesium alloys containing small amounts of silicon, aluminium, zinc, lead, or manganese.

ANALYSIS.—The analysis of cobalt and nickel. *Die Metallbörse*, November 16, pp. 2256-2257 (in German).

The analysis of "Stellite," "Akrite," and similar alloys. E. Deiss. *Metall. u. Erz*, November, Vol. XXIV, part 22, pp. 537-541 (in German). Methods are outlined for the analysis of the hard cutting alloys (containing tungsten, chromium, nickel, molybdenum, etc.) which are usually very difficultly soluble in acids.

CORROSION.—Degasification of metals and its relation to corrosion. F. M. Dorsey. *Ind. Eng. Chem.*, November 1, pp. 1219-1225. The work described is the commercial development of the process devised by Charles P. Madsen for the degasification of metals and for the subsequent plating of these metals in a manner to produce a continuous homogeneous, protective metallic film. Under certain conditions a nickel plate which is soft, ductile, annealable, and malleable may be produced, thus permitting rolling, drawing, spot-welding, soldering, and other steps in the fabrication of the plated metal. Heavier coats of protective metals like chromium can be secured more readily upon base metal thus prepared, and through the perfection of the coating a notable contribution to corrosion resistance is claimed.

GENERAL.—Researches on sodium sulphide melts. H. Fincke. *Die Metallbörse*, November 26, pp. 2637-2638 (in German).

IRON AND STEEL.—The fragility of steel. P. Régnault. *Rev. de Métallurgie*, September, pp. 509-515 (in French).

Silica bricks for steelworks. A. H. Middleton and C. Bride. *J. West of Scotland Iron and Steel Inst.*, Vol. 34, part 5, pp. 64-75.

Alkalies in the blast furnace. W. Macconnachie. *J. West of Scotland Iron and Steel Inst.*, Vol. 34, part 6, pp. 79-84.

The treatment of articles made of ferrous alloys with solutions of complex phosphates with the object of protecting them against corrosion. J. Cournot. *Comptes rend.*, November 14, pp. 1041-1043 (in French). The author has compared experimentally the corrosive action of a number of acid, alkaline, and salt solutions, also steam, on phosphate-treated mild steel with that on the same steel protected in other ways, such as by galvanising and nickel plating.

FUEL.—The behaviour of coke in the blast furnace. T. L. Joseph. *Blast Furnace and Steel Plant*, November, pp. 516-523. A discussion of the various factors effecting efficiency of combustion.

The properties of metallurgical coke. R. P. Hudson. *Blast Furnace and Steel Plant*, November, pp. 526-527. The properties which should be possessed by coke in order that it may be most efficiently used in the blast furnace are set forth.

SINGLE METALS.—New methods for the electrolytic production of zinc from copper-rich and copper-poor roasted pyrites. H. Paweck and H. Wenzel. *Z. angewandte Chem.*, October 6, pp. 1107-1112 (in German).

Preparation and application of the light metal beryllium. K. Illig. *Z. angew. Chem.*, October 20, pp. 1160-1163 (in German).

The chemical properties of pure aluminium. C. Matignon and J. Calvet. *Comptes rend.*, November 7, pp. 909-912 (in French). Aluminium of 99.8-99.98 per cent. purity does not appear to be more resistant to dilute soda solutions than the less pure metal, but is resistant to dilute pure hydrochloric acid. In the latter case the resistance is decreased in presence of certain metal salts.

The reduction of nickel and zinc oxides. J. Barwasser. *Metall. u. Erz*, November, Vol. XXIV, part 21, pp. 510-520. A detailed study of the reducing action of calcium silicide on zinc and nickel oxides; the author concludes that this reducing agent can be economically employed in the preparation of the metals.

Developments in conductors (electric). v. Zeerleder and M. Bosshard. *Z. Metallkunde*, November, pp. 459-470 (in German). An account of the application of aluminium in electric conductors and the properties desirable in the metal when used for this purpose.

The Use of German Metallurgical Coke

THE fact that German metallurgical successfully competed with Durham coke in Middlesbrough was referred to by Mr. Frank Hodges at the meeting of the Institute of Fuel last week, who spoke of the use of German metallurgical coke at Middlesbrough. "German competition," he said, "still holds good in Middlesbrough, not only as regards price but as regards quality. It is obviously up to you technicians and practical men attached to the coking and byproducts industry to take up that challenge." In a paper on the British coking industry Mr. Robert Ray said that in this country we were much behind our competitors on the Continent, and if the coking industry was to be revived, and its hard-pressed friends in the iron and steel trades were to be assisted in their struggle for existence, it was essential that the situation be faced and tackled courageously. Apart from half a dozen up-to-date plants, the coking installations of Great Britain were to all intents and purposes what they were in 1918. The coking and the iron and steel industries must stand or fall together. Everything possible should be done, therefore, to encourage the leaders in both industries to get together and hold counsel as to the steps which must be taken to regain their place in the markets of the world.

Aluminium Data

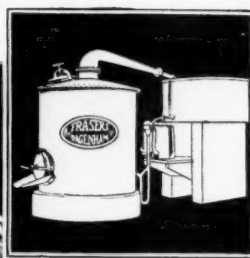
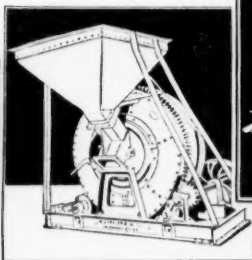
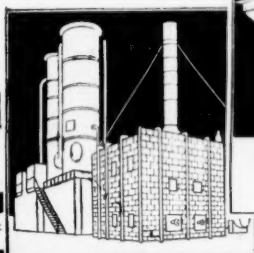
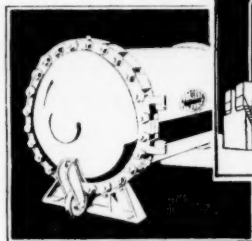
THREE very useful little booklets of data sheets have been issued by the British Aluminium Co., Ltd., of Adelaide House, London, E.C.4. The first, entitled "Aluminium Data," deals with rivets (giving dimensions and other useful data); matting (standard forms and sizes); sections; and operations such as annealing, heat treatment, machining, welding, jointing, polishing, cleaning, etc. The physical, mechanical, and electrical constants of aluminium are also given. The second booklet is entitled "Aluminium Sheet, Strip, and Circles"; and the third, "Aluminium Sections and Matting," and both contain much information respecting these products. The booklets are so made that additional sheets sent out by the company, ready punched, may be inserted. The booklets contain much information and many useful "tips," and should be in the hands of all those who use aluminium and aluminium products.

Financial Control of Ontario Nickel

ACCORDING to the Toronto Bureau of the *Financial Times* of Montreal, Canadians now hold five-eighths of the outstanding stock of the International Nickel Co., Inc. This compares with something like 15 per cent. held by Canadians three years ago. While the number of Canadian shareholders is much larger than it ever was before, the purchases of a few big interests account for 700,000 shares. The issued common stock totals 1,673,384 shares.

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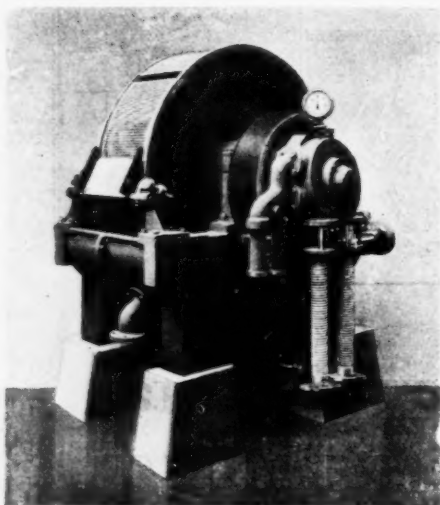
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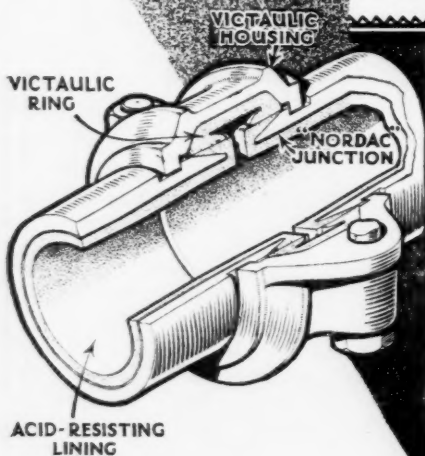
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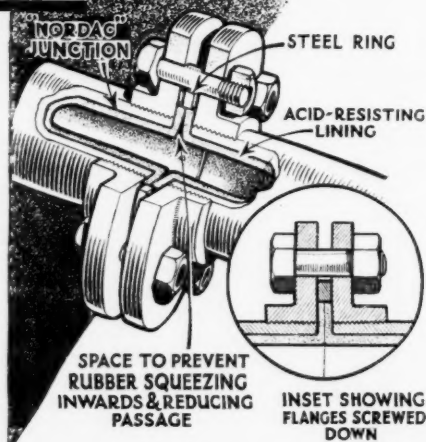
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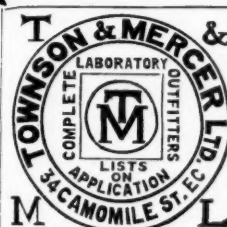
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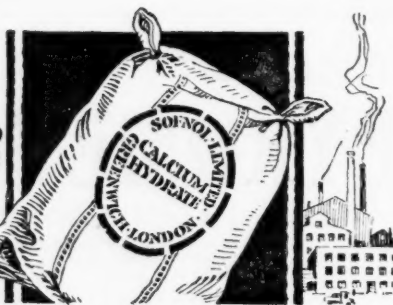
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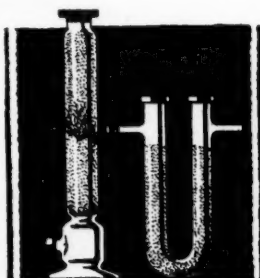
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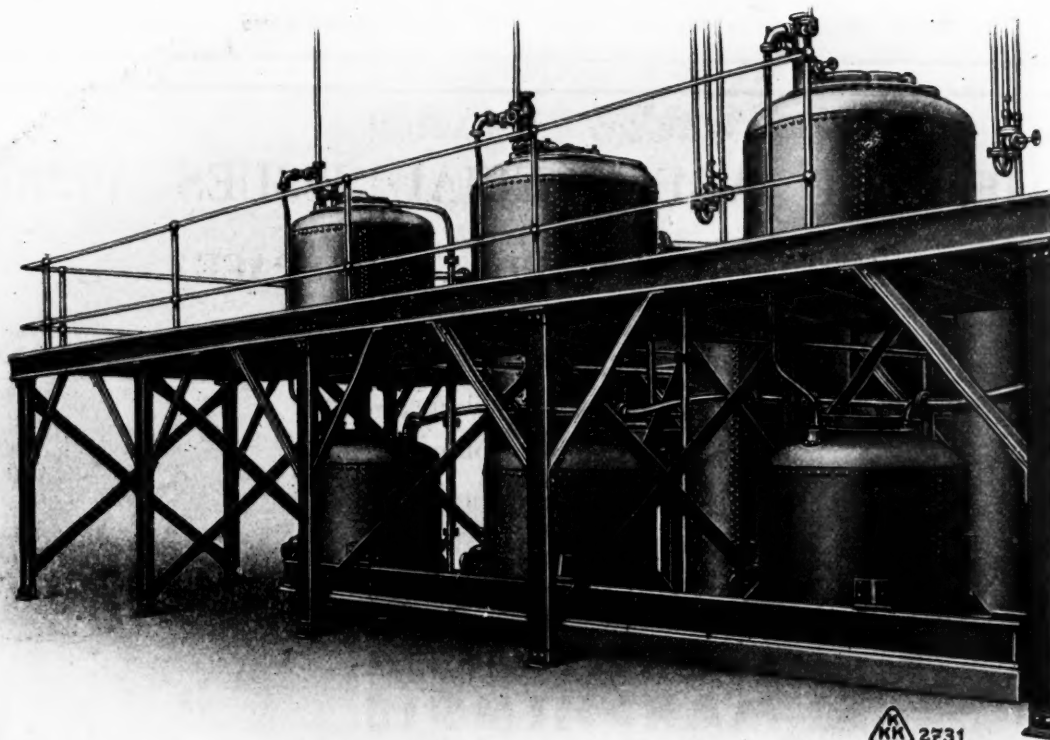
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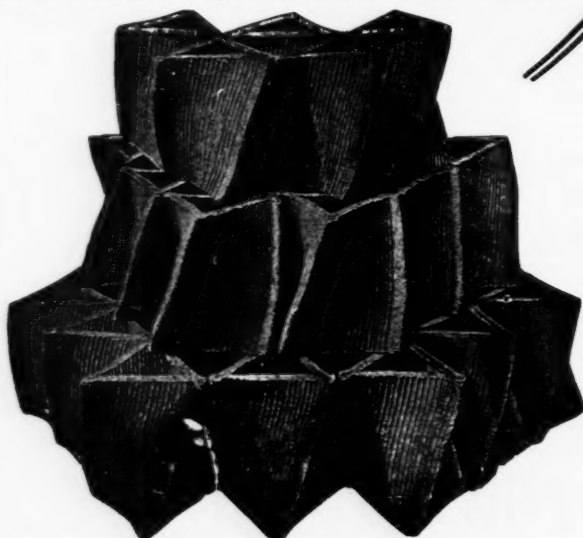
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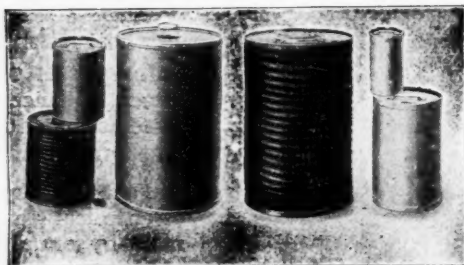
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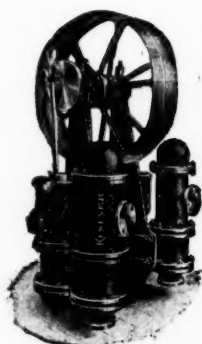
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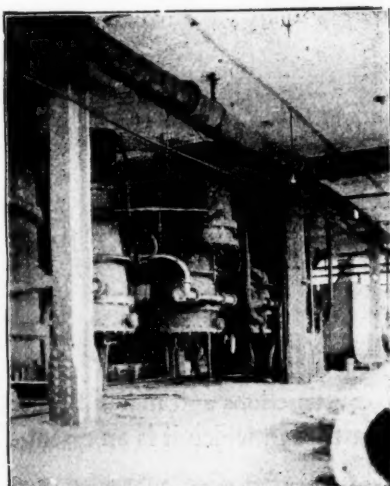
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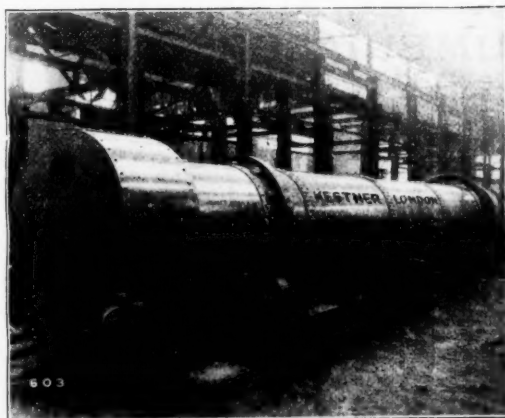
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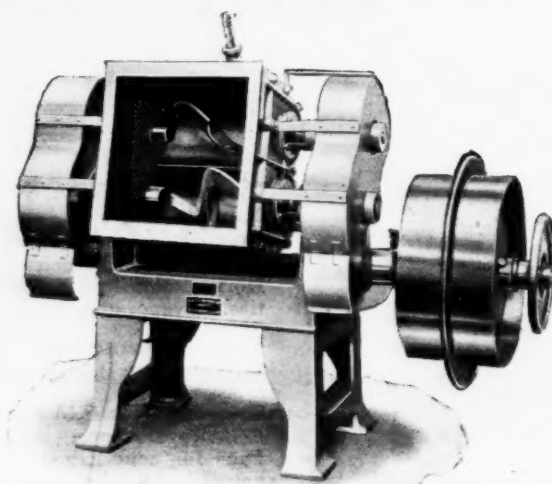
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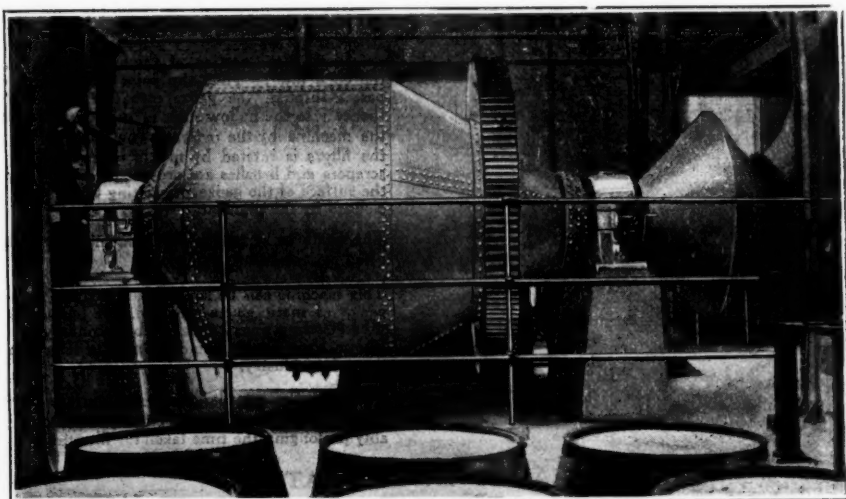
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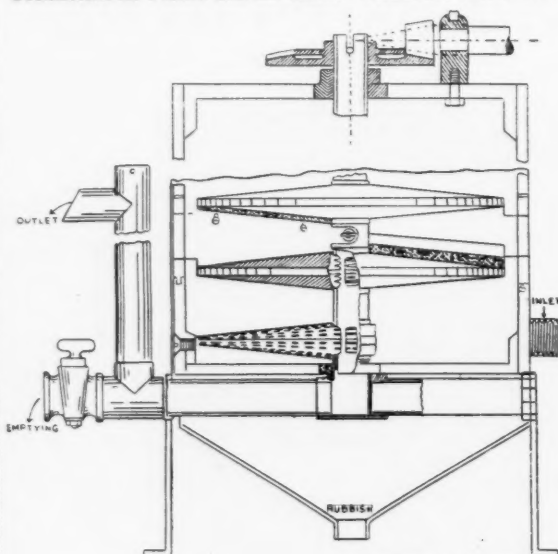
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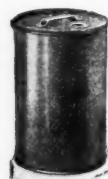
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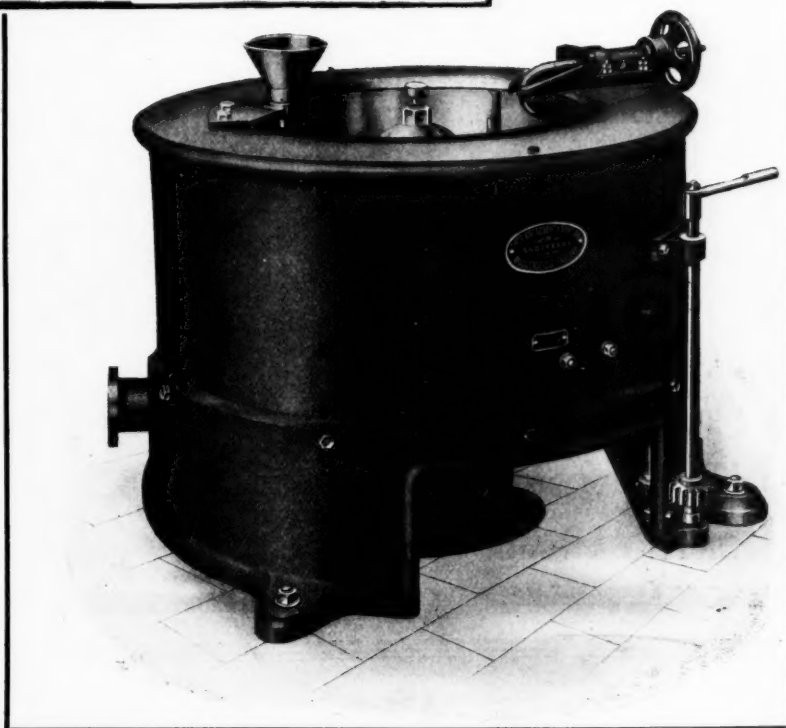
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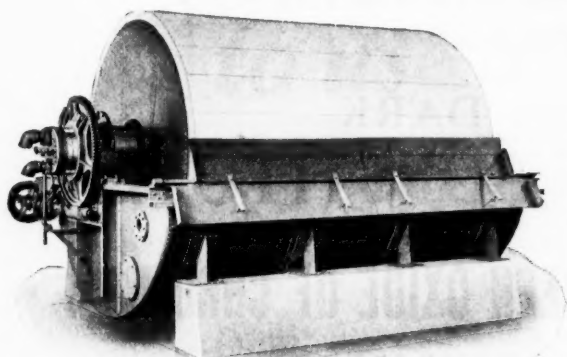
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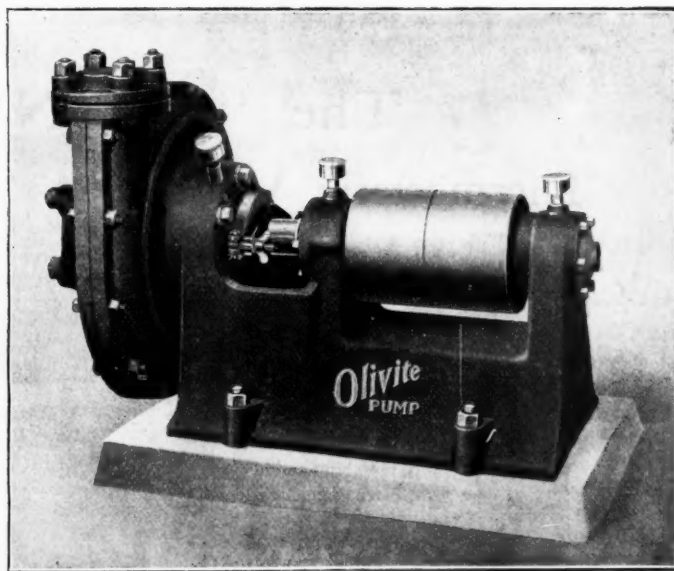
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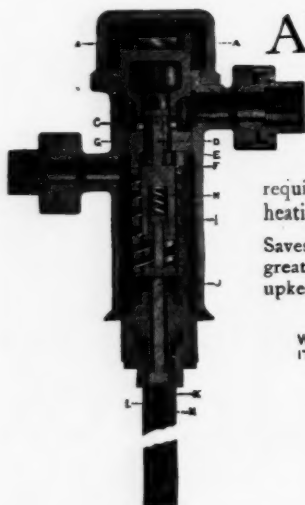
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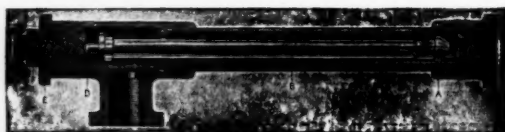


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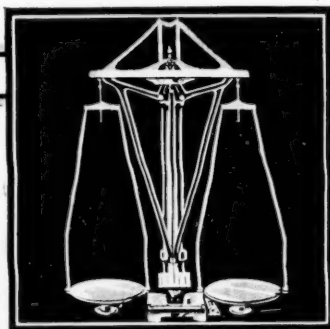
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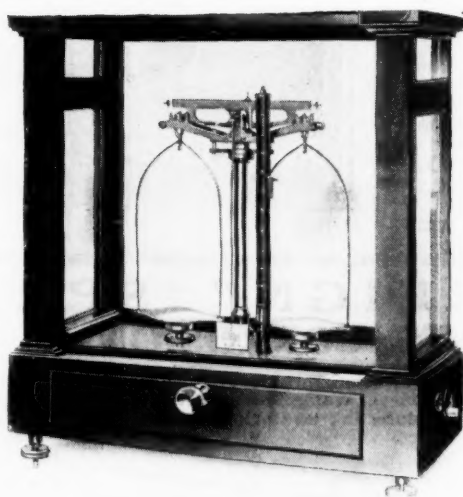
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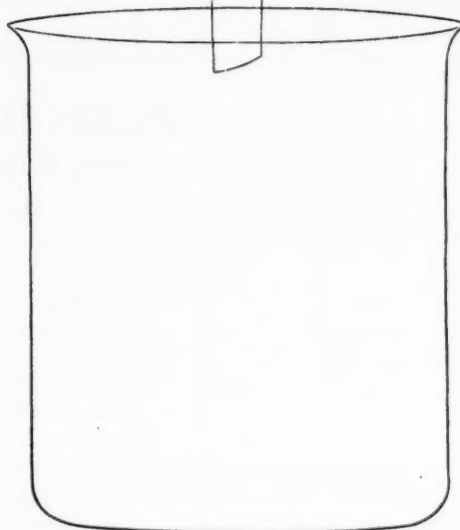
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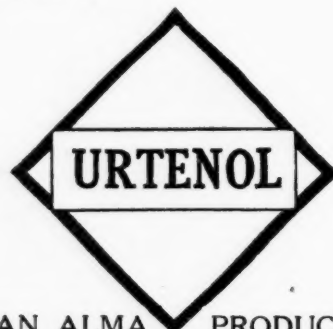
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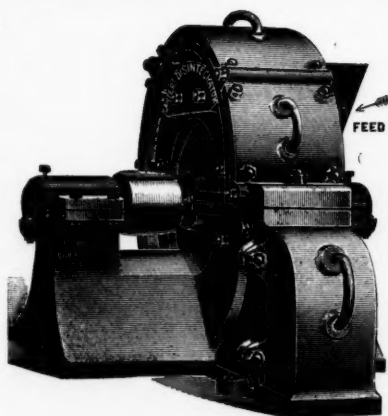


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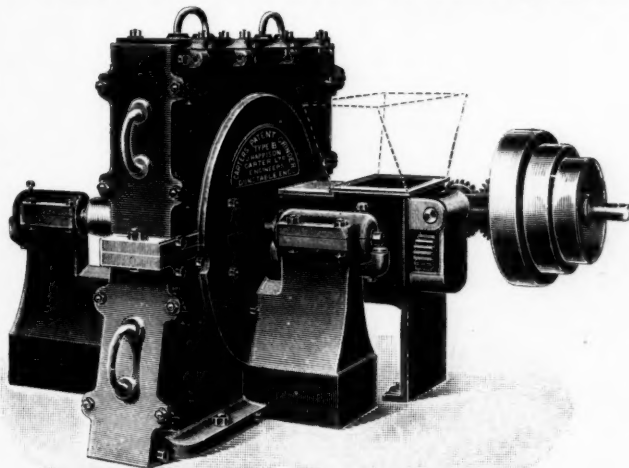
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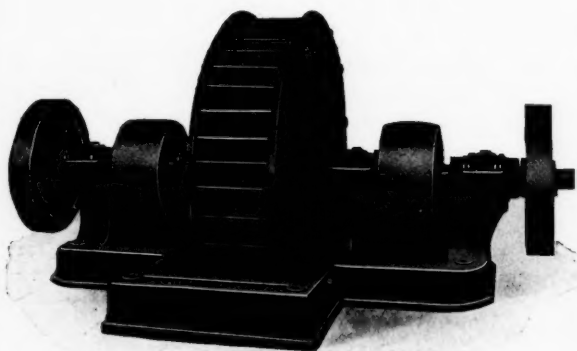
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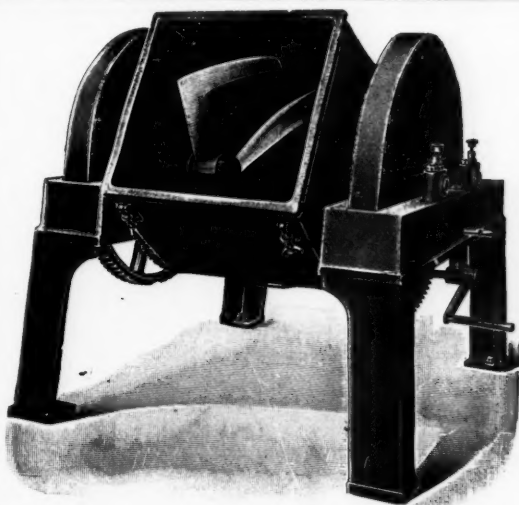
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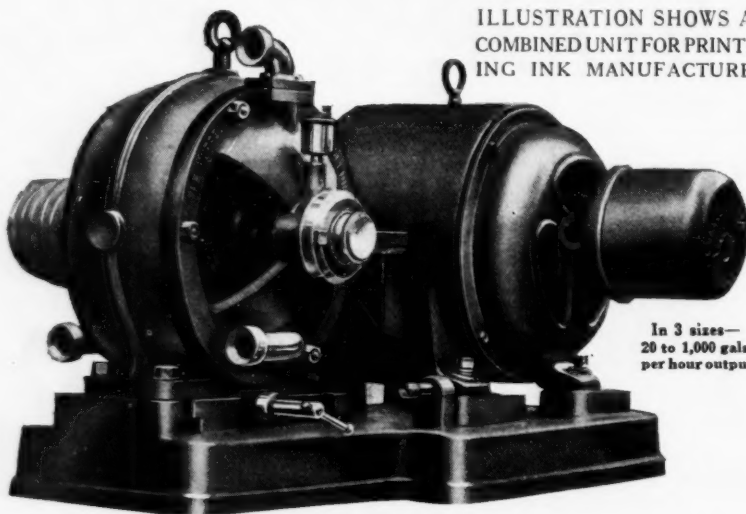


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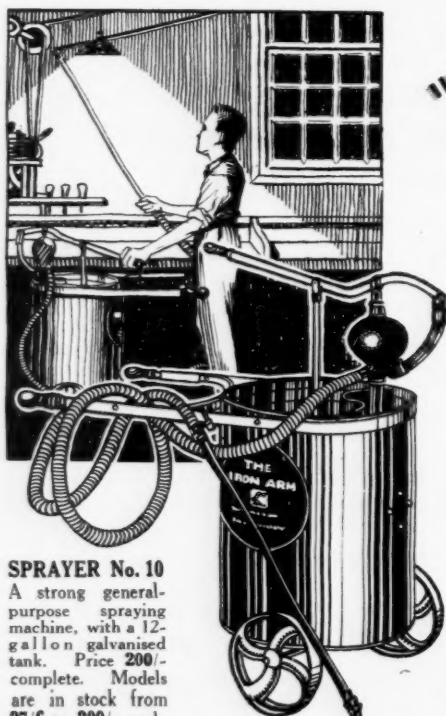
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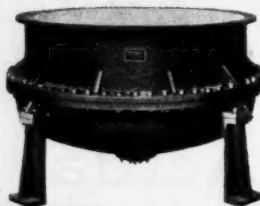
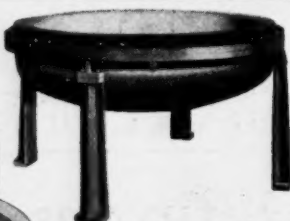
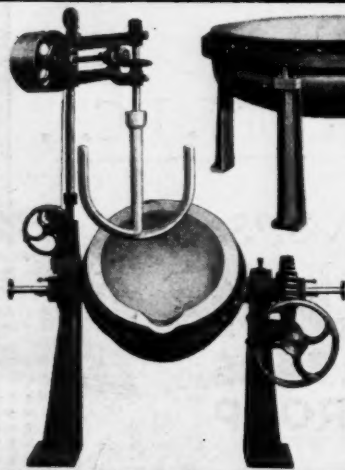
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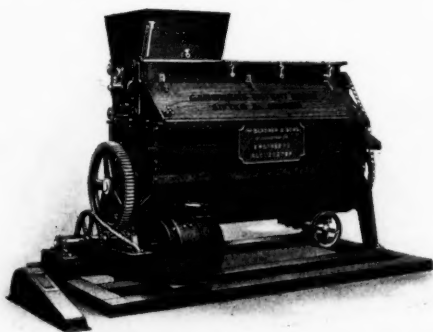
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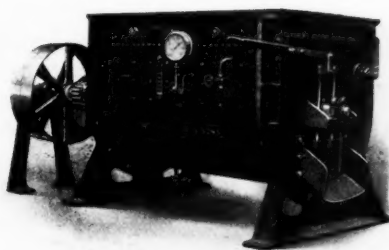
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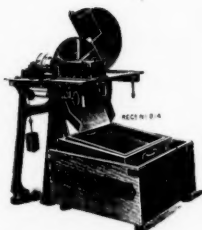
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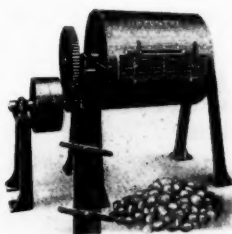
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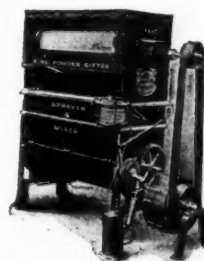
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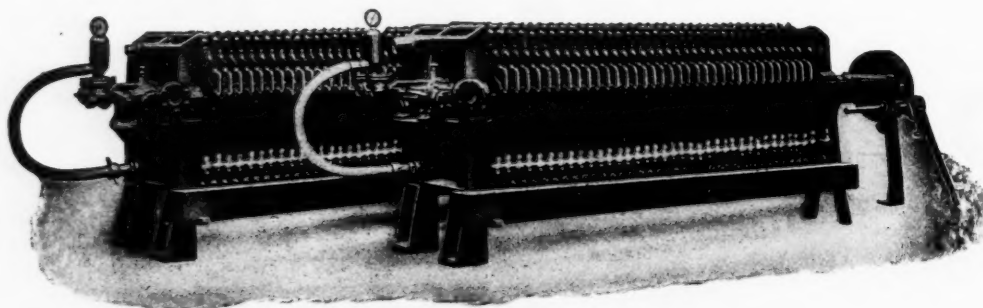
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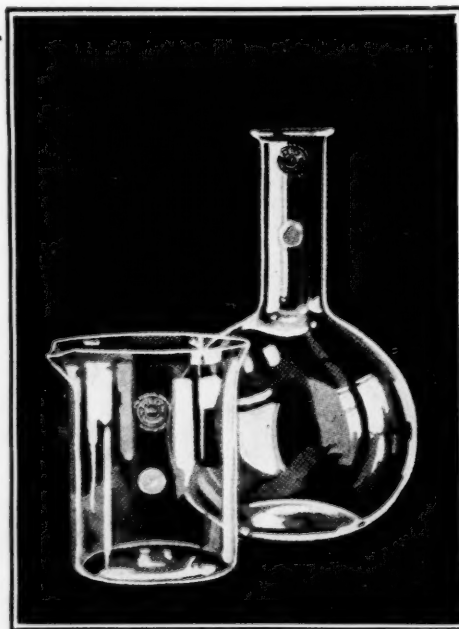
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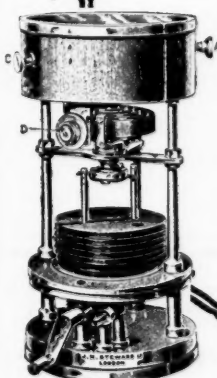
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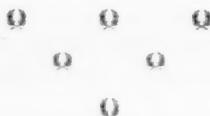
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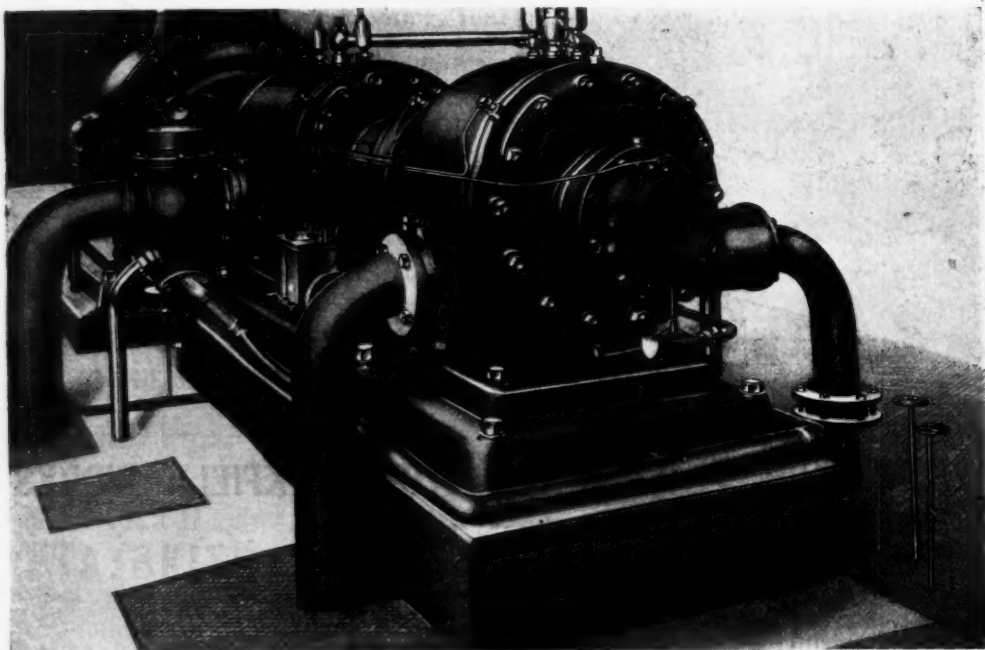
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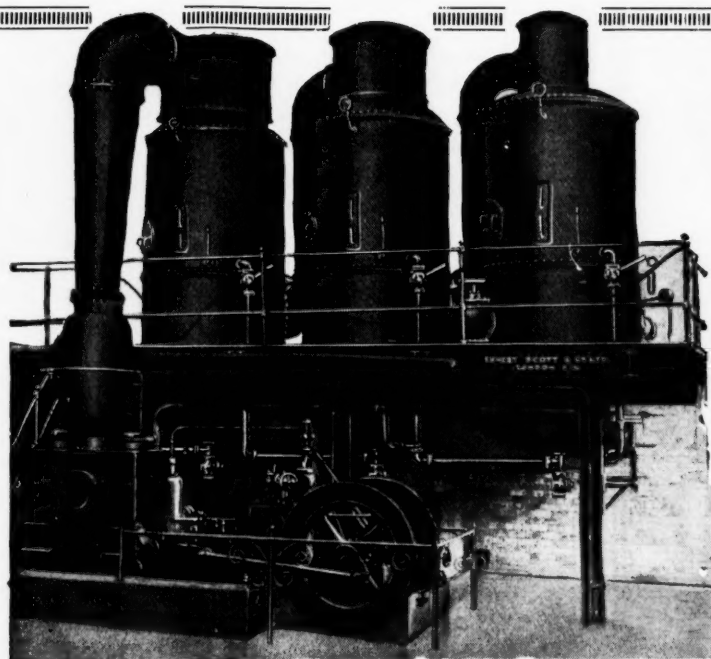
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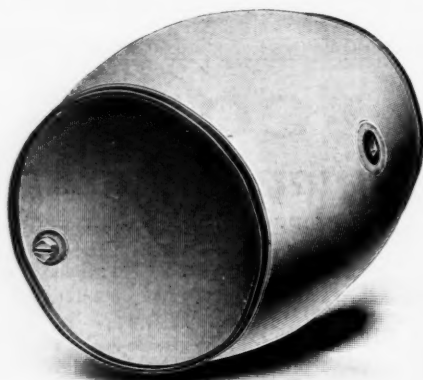
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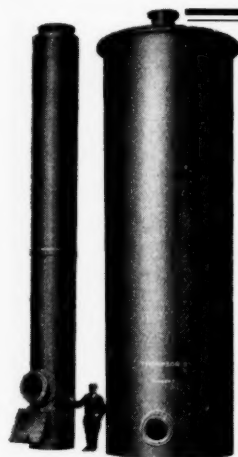
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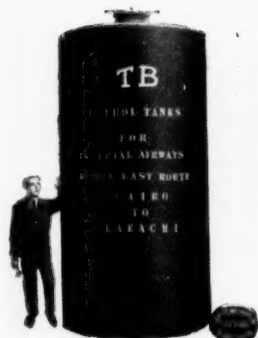
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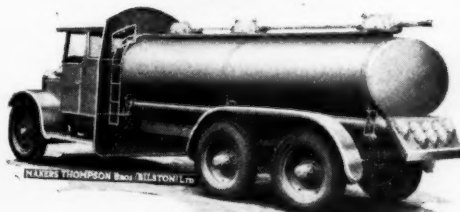
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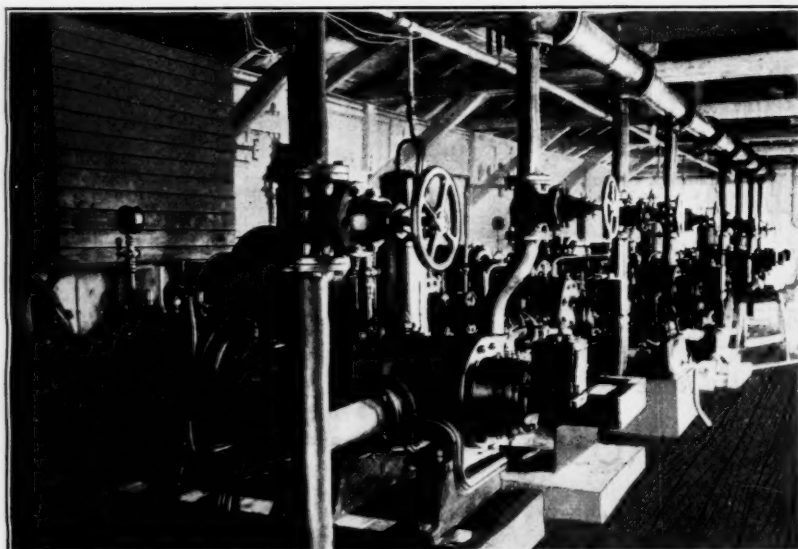
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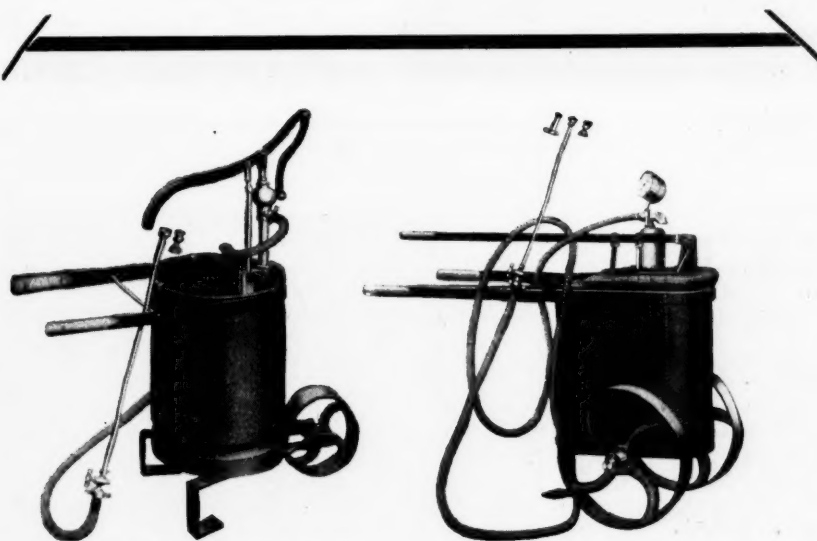
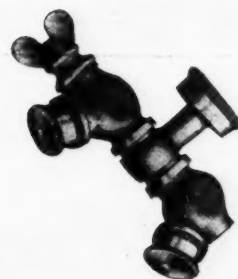
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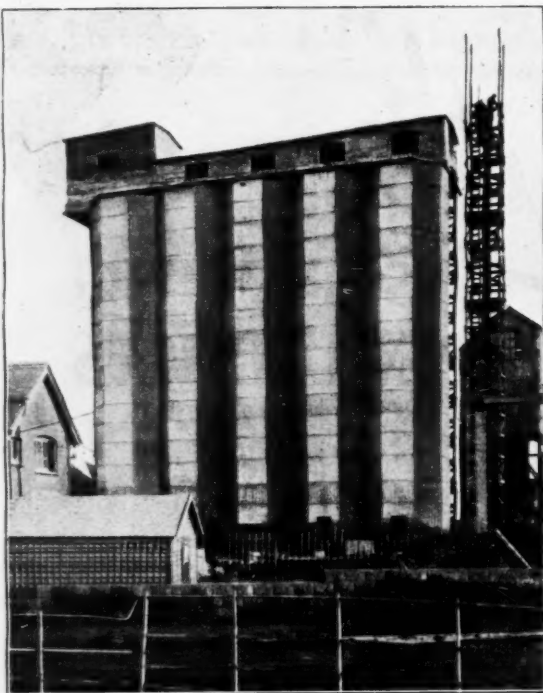


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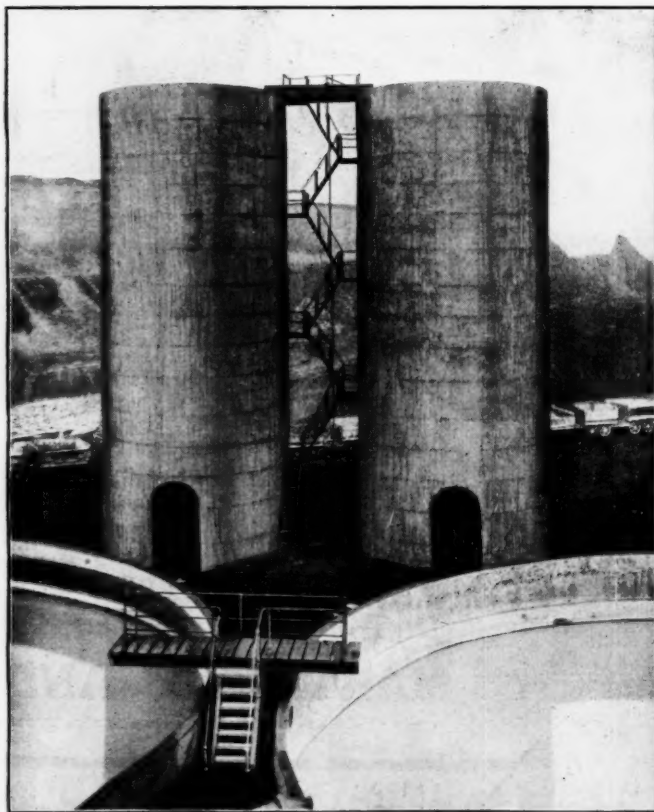
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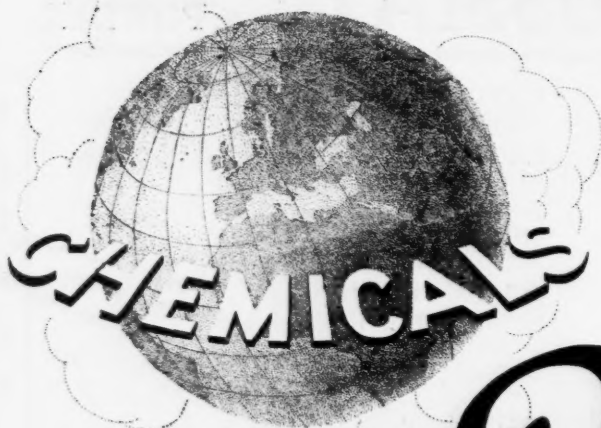
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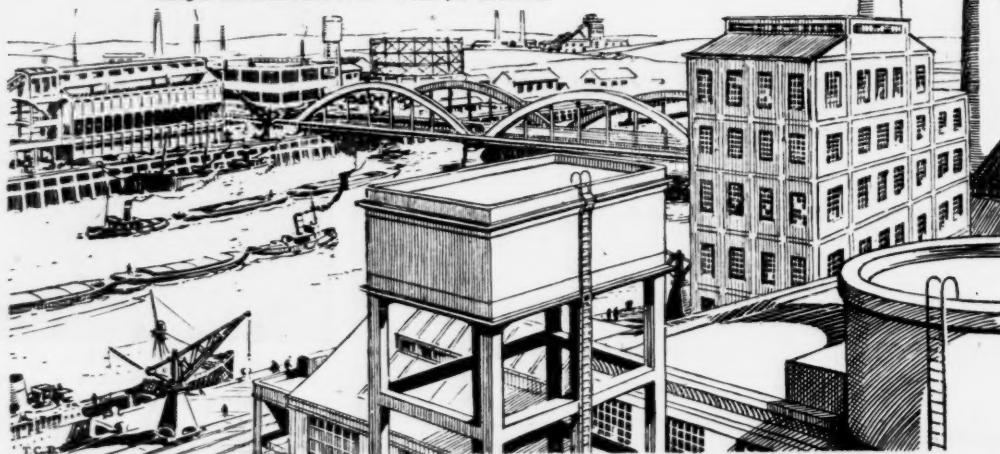
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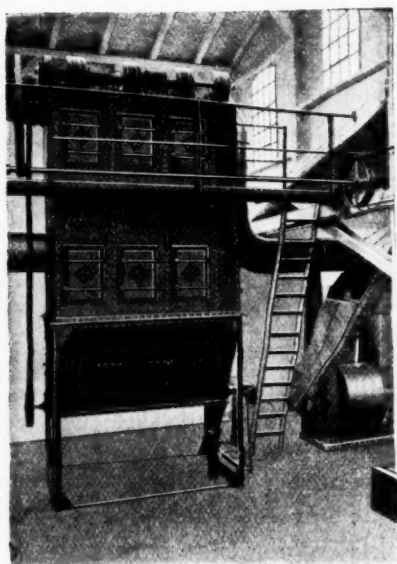
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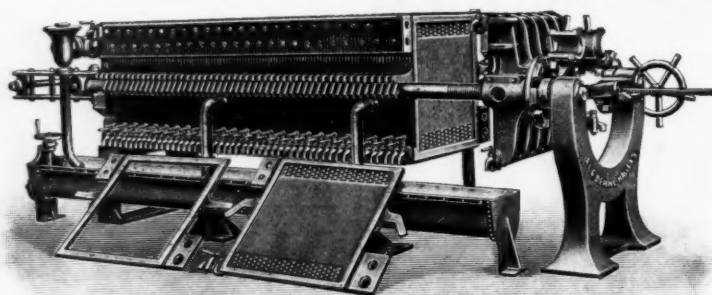
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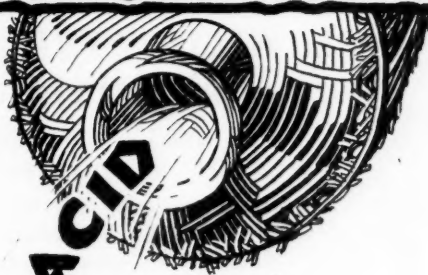
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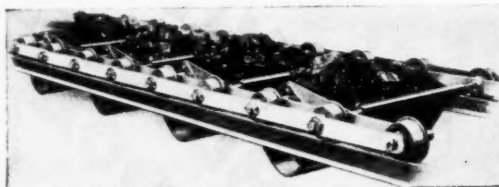
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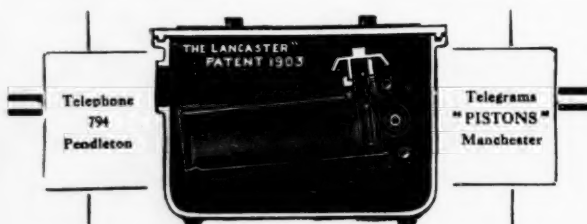
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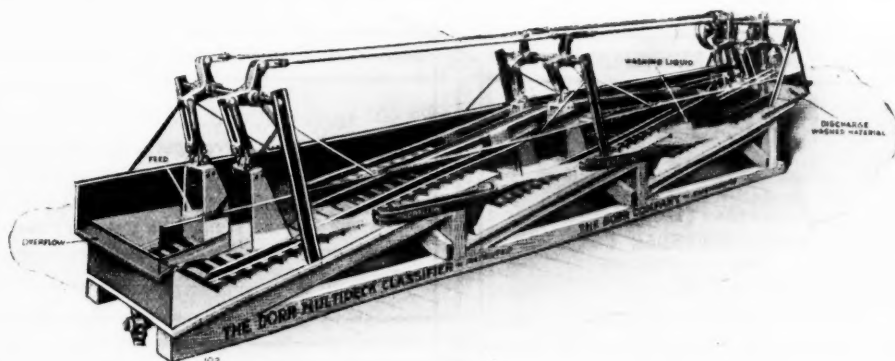
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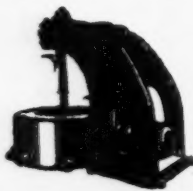
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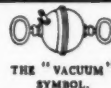
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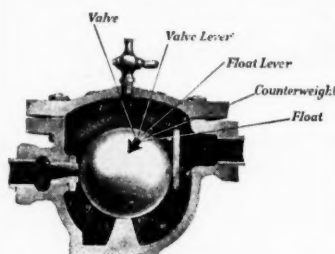
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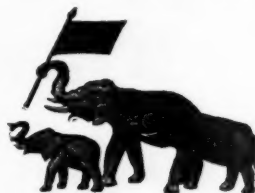
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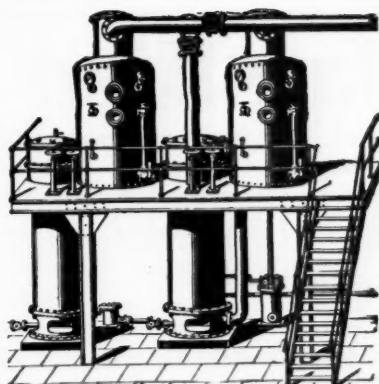
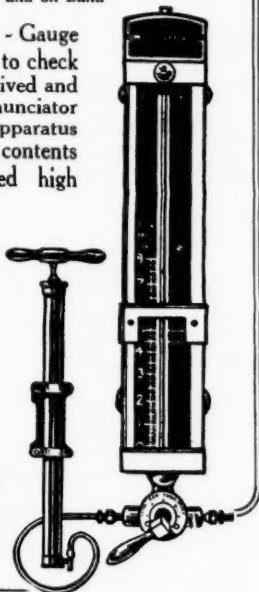
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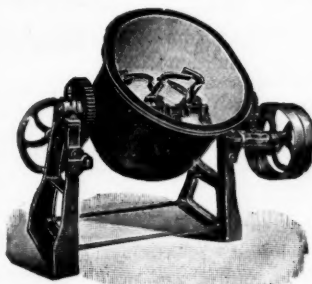
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